Final Technical Report
submitted to
Department of Geophysics
Niels Bohr Institute for Astronomy, Physics and Geophysics
University of Copenhagen
Copenhagen, DENMARK

Measurements of the Total CO_2 Concentration and Total Alkalinity in Seawater collected during the SONNE Cruise 102, May-June, 1995

by

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Lamont-Doherty Earth Observatory of Columbia University
Palisades, NY 10964, U. S. A.

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Abstract

The total CO_2 concentration and total alkalinity were determined in about four hundred water samples collected at 17 stations during the SONNE Cruise 102, May-June, 1995, in the southeastern Pacific near Chilean coasts. The water samples were shipped to the land-based laboratory at Lamont-Doherty Earth Observatory for analyses. The total CO_2 concentration was determined by coulometry with a precision of about $\pm$ 1.0 μmol/kg. Analyses of SIO Certified Reference Solutions along with the SONNE samples show that our results are consistent with the Keeling's manometric CO_2 measurements within 1.4 μmol/kg. The total alkalinity was determined by a new method: the total CO_2 concentration in a water sample was determined immediately after pCO_2 was measured in a sample bottle at 20.0 °C, and these values were used to compute the total alkalinity. Two different sets of the dissociation constants for carbonic, boric, phosphoric and silicic acids in seawater were used for the computation, and the two sets of alkalinity values are presented in the data tables. The precision of the computed alkalinity values in each set has been estimated to be about $\pm$ 2 μeq/kg on the basis of deep water values. However, the alkalinity values computed using the dissociation constants listed in the DOE Handbook (1994) are systematically smaller by about 7 μeq/kg than those computed using the dissociation constants selected by Peng et al. (1987). The alkalinity values computed using Peng. et al. scheme are about 3.5 μeq/kg smaller than those determined titrimetrically by A. G. Dickson for SIO Reference Solutions.

The distribution of total alkalinity and total CO_2 concentration in the water column is governed primarily by mixing of major water masses which include the Subtropical Underwater (centered around 200 meters), AAIW (centered around 600 meters), North Pacific Return Water (centered around 2500 meters) and AABW. The alkalinity increases with depth rapidly from surface water values of about 2270 μeq/kg to about 2375 μeq/kg at 1500 meters, and exhibits a broad maximum (about 2420 μeq/kg) centered around 3000 meters. The total CO_2 concentration increases with depth from the surface value of about 2020 μmol/kg to about 2315 μmol/kg at 2000 meters exhibiting a broad maximum at this depth and decreases to about 2300 umol/kg at the sea floor. The decrease of alkalinity and total CO_2 concentration toward the sea floor is more prominent at the southwestern stations, and this is attributed to the influx of AABW. However, at the Chile Trench station, Station 3348, the signals for AABW are weak at 5000 meters.

The hydrographic data merged with the alkalinity and total CO_2 data are listed in the data tables at the end of this report.

Acknowledgements

We thank Prof. Gary Shaffer of the Department of Geophysics, Niels Bohr Institute for Astronomy, Physics and Geophysics, University of Copenhagen, Denmark, for sponsoring our study. Without his encouragement, this study would not have been competed. We also thank Dr. Osvaldo Ulloa and his group for water sampling at sea aboard the Research Ship SONNE and for providing us the hydrographic data. We acknowledge that the hydrographic data listed in the data tables of this report were provided by Dr. Ulloa.

The TCO_2 values in water samples were determined by Rebbeca Esmay of Lamont-Doherty. Stew Sutherland performed the task of data quality check and prepared the illustrations and tables used in this report. Their dedicated services are gratefully acknowledged. We also thank Dr. Andrew Dickson of the Scripps Institution of Oceanography for providing the Certified Reference Solutions and the total CO_2 concentration and alkalinity data for these solutions.

1. INTRODUCTION

This report summarizes the results of measurements of total CO_2 concentration and alkalinity in about 400 water samples collected during the SONNE Cruise # 102, May-June, 1995, in the eastern South Pacific Ocean near the coast of Chile. The area of the investigation includes highly productive coastal upwelling zones, the Peru Current, and deep water areas between 28°S and 43°S latitude and between 72°W and 88°W longitude. The stations are arranged along three east-west sections at 28°S, 35°S and 43°S nearly perpendicular to the Chilean coast. The locations of 17 stations where the CO_2-alkalinity samples were collected are shown in Fig. 1.

2. METHODS OF MEASUREMENTS

2-a) Water Samples:

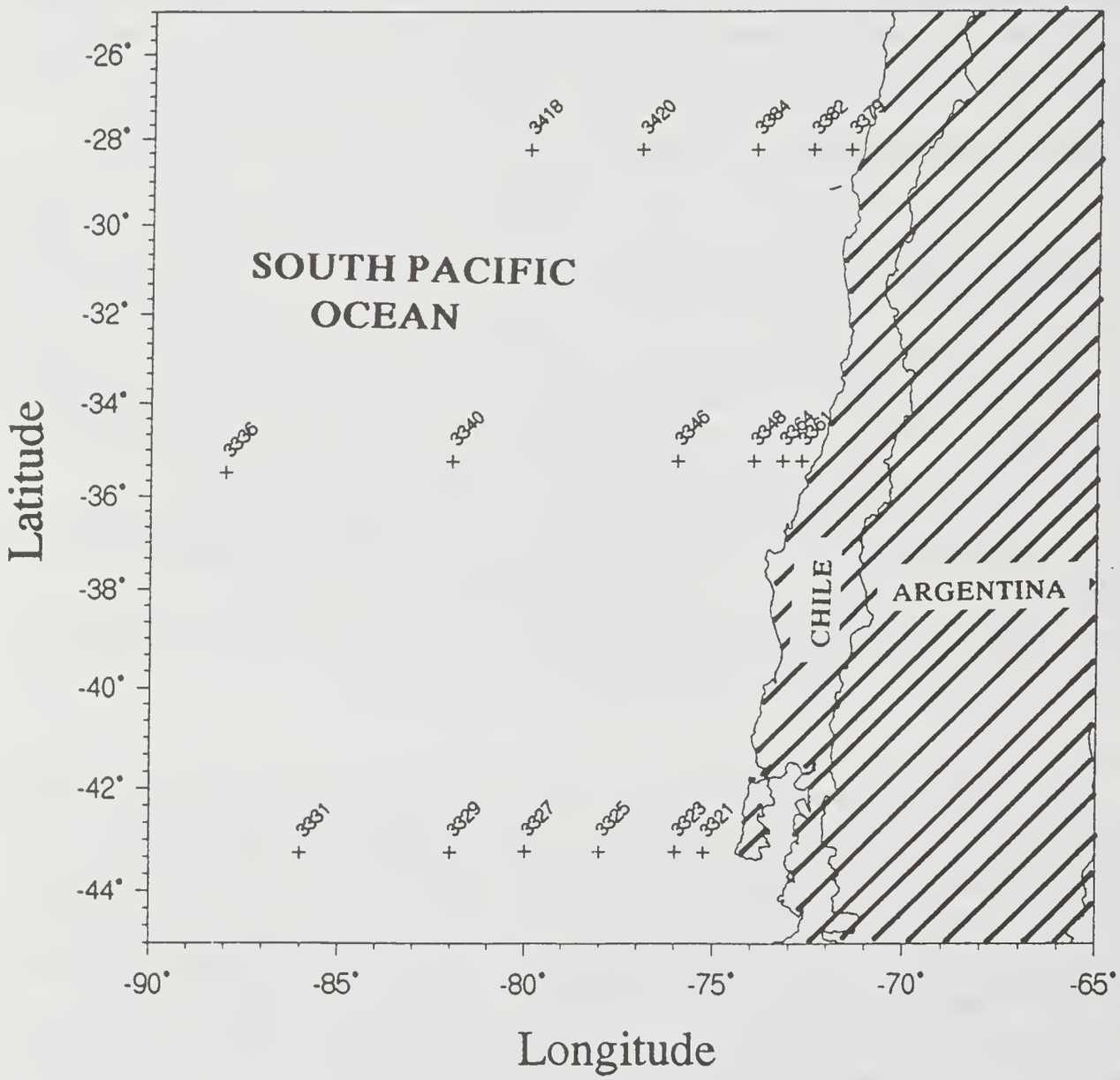
Samples for TCO_2 and alkalinity analyses were drawn from the Niskin bottles of the rosette casts directly into 250 ml Pyrex glass reagent bottles with ground standard-taper stoppers, sealed with silicone vacuum grease. Immediately after sample collection, 200 µl of 50% saturated mercuric chloride solution was added to prevent biological alteration of TCO_2 and alkalinity during storage and shipment to the land-based laboratory of the Lamont-Doherty Earth Observatory (LDEO). The measurements were made about 8 months later in January through February, 1996.

2-b) Total CO_2 Concentrations:

The coulometric analysis system which was used to measure the total CO_2 concentration in seawater samples (TCO_2) is described by Chipman et al. (1993) and is summarized below. This system consists of a coulometer (Model 5011) manufactured by UIC Inc. (Jolliet, IL) and a sample introduction/CO_2 extraction system of LDEO design. A precisely known mass of seawater sample (ranging between 18 and 21 grams) is introduced manually through a rubber seotum into a CO_2 extraction vessel using a syringe equipped with a needle and a small valve. The mass of water sample used for analysis was determined by weighing the syringe before and after a sample injection with a high precision balance. Repeated measurements yielded a precision of $\pm$0.03%.

The seawater sample in the extraction vessel is acidified with ~1 ml of 8.5% phosphoric acid introduced through a sidearm of the extraction chamber.

Fig. 1 Station locations, where the water samples for CO_2-alkalinity measurements were collected during the SONNE # 102 Cruise, May-June, 1995.

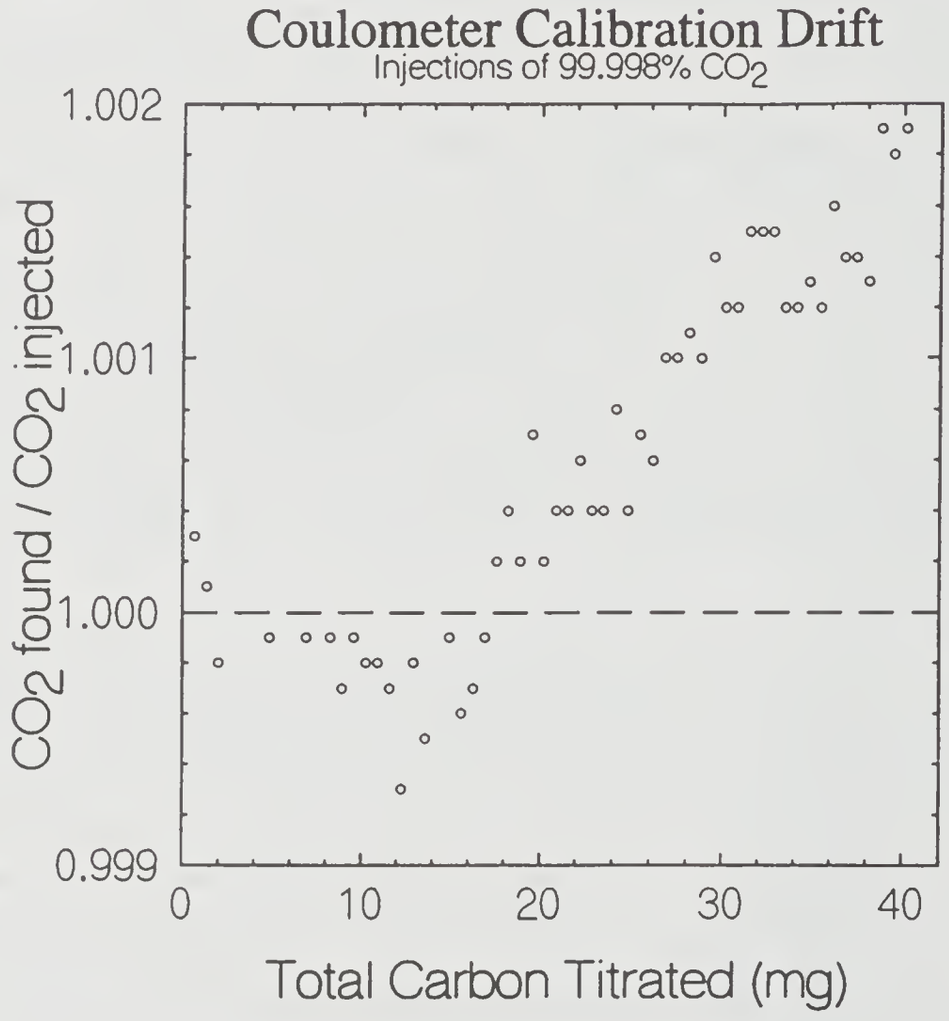


The evolved CO_2 is stripped from the sample and transfered into the electrochemical cell of the CO_2 coulometer by a stream of CO_2-free air. In the coulometer cell, the CO_2 is quantitatively absorbed by a solution of ethanolamine in dimethylsulfoxide (DMSO). Reaction between the CO_2 and the ethanolamine forms the weak hydroxyethylcarbamic acid. The pH change of the solution associated with the formation of this acid results in a color change of the thymolphthalein pH indicator in the solution. The color change, from deep blue to colorless, is detected by a photodiode, which continually monitors the transmissivity of the solution. The electronic circuitry of the coulometer, on detecting the change in the color of the pH indicator, causes a current to be passed through the cell, electro-generating hydroxyl (OH^-) ions from a small amount of water in the solution. The OH^- generated titrates the acid, returning the solution to its original pH (and hence color), at which point the circuitry interrupts the current flow. The product of current passed through the cell and time is related by the Faraday constant to the number of moles of OH^- generated to titrate the acid and hence to the number of moles of CO_2 absorbed to form the acid. A thermostated double walled titration cell is used to extract the heat generated in the cell during titration. This eliminates the shifting of the endpoint of the titration due to change in temperature of the cell solutions.

The coulometer is calibrated using research grade CO_2 gas (99.998% pure) introduced into the carrier gas line upstream of the extraction chamber using two fixed-volume sample loops alternately on a gas sampling valve. The filled loops are vented to the atmosphere, and the barometric pressure was measured using a high precision electronic barometer. The loop temperatures are measured to ± 0.02 °C with a thermometer calibrated against one traceable to NIST, and the non-ideality of CO_2 is incorporated in the computation of the loop contents. The volume of the loops was initially determined by the weight difference between the loop/injection valve assembly empty and filled with water. Repeated measurements indicate that the volumes of the loops are precise to $\pm 0.02\%$. The coulometer is calibrated several times daily using the gas sampling system described above.

The calibration factor, which represents the ratio between the number of moles of CO_2 in the loop and the reading of the coulometer, changes during the use of a titration cell. Depending upon the condition of the coulometric solution in the titration cell, the calibration factor varies around the ideal ratio of unity by a few tenths of a percent. Fig. 2 shows the typical variation of the calibration factor as a function of the cumulative amount of CO_2 titrated by a cell and indicates that it may be represented by a quadratic form. If changes in the calibration factor were not taken into consideration, a systematic error of

Fig. 2 Change in the coulometer calibration factor as a function of the amount of CO_2 titrated. The change is expressed in terms of the ratio (Moles of CO_2 detected by coulometer)/(Expected number of moles of CO_2 injected into coulometer).



as much as 4 to 5 µmol/kg would be introduced between the samples analyzed in the early and late stages of a single coulometric solution. Accordingly, the CO_2 concentration in each seawater sample was determined using a calibration factor estimated from an equation fit to the calibration data obtained for each titration cell. Generally, a titration cell needs to be cleaned and filled with new solution after about 40 samples are analyzed. Beyond this number of analyses, the cell begins to behave erratically yielding unreliable analytical results. The working equation used for computing the coulometer/cell calibration factor (CF) is as follows.

$$CF = (12.011 * 10^6) * PA * [LPV * (1 + 3 * \alpha) * (TK(calib) - TK(lp))] / \{MV(CO_2) * [RD - (TM * BL)]\}$$

where

$12.011 * 10^6$	=	Atomic weight (in µgrams) of carbon,
PA	=	Pressure (in atm) of CO_2 gas in loop at time of calibration,
LPV	=	Volume of calibration valve loop (in ml) at TK(lp),
α	=	Linear thermal expansion coefficient of stainless steel, $1.73 * 10^{-5}$ °K^{-1},
TK(lp)	=	Temperature (in °K) at which loop volume was determined,
TK(calib)	=	Temperature (in °K) of CO_2 in loop at time of calibration,
$MV(CO_2)$	=	Molar volume of CO_2 (in ml) at temperature of calibration,
RD	=	Coulometer reading (in µgrams-carbon),
TM	=	Length of calibration run (in minutes), and
BL	=	Instrumental blank (or background) rate (in µgrams of carbon/min).

The following relationships were used for the computation of the total CO_2 concentration in seawater samples using the coulometer;

$$TCO_2\ (\mu mol/kg) = CF * DF * [RD - AB - (TM * BL)] / (12.011 * WT)$$

where

CF	=	Calibration factor of coulometer/cell combination interpolated to the time when the measurement was made.
DF	=	Dilution factor to account for dilution of seawater sample by CO_2-free mercuric chloride poisoning solution: DF = [(sample volume) + (poison volume)]/(sample volume) = 1.0008 for 200 µl of mercuric chloride solution in 250 ml sample.

RD = Coulometer reading (in μgrams of carbon).

AB = Acid blank (in μgrams) of carbon to account for a small amount of CO_2 in phosphoric acid solution added to sample; determined by measuring CO_2 stripped from larger volume of acid, typically less than 0.03% of amount of CO_2 in seawater sample.

TM = Length of analytical run (in minutes).

BL = Instrumental blank rate (in μgrams of carbon/min.), typical blank rate being 0.01 to 0.02 μgrams of carbon/min.; the maximum acceptable blank rate of 0.05 grams of carbon/min results in a correction of about 0.1% over the normal length of an analytical run.

WT = Mass (or weight) of seawater sample (in kg) injected into stripping chamber, determined by weighing injection syringe on high orecision balance before and after injection.

12.011 = Atomic weight (in grams) of carbon.

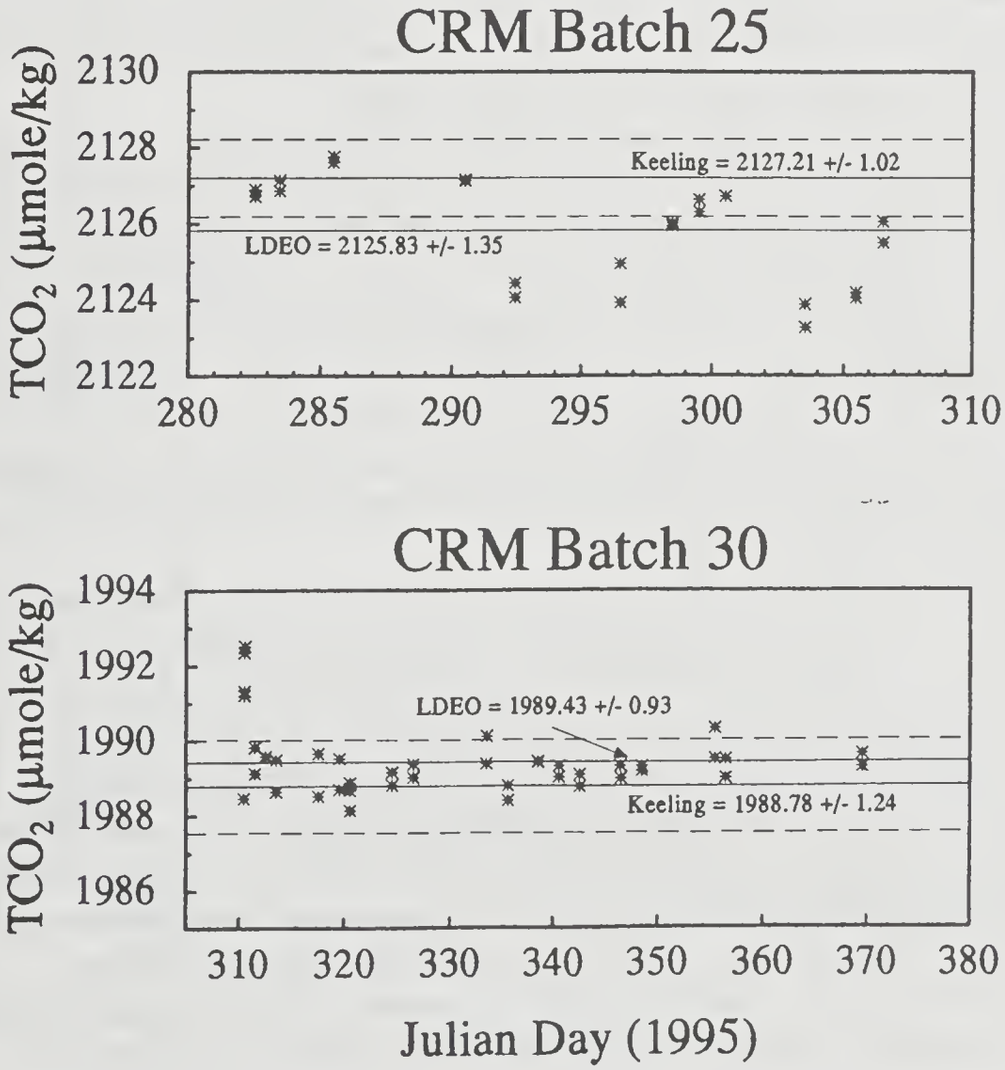
2-c) Analyses of Certified Reference Solutions for TCO_2:

For the purpose of quality control of the total CO_2 analyses, Scripps Instituion of Oceanography (SIO) Reference Solutions (Batches # 25 and 30) were measured 63 times along with the SONNE samples. The results of the coulometric determinations of the total CO_2 concentration in the SIO Reference solutions are summarized and compared, in Fig. 3 and Table 1, with those of the manometric determinations made by C. D. Keeling of SIO. The difference between the mean values for these two independent sets of measurements ranges between + 1.4 and -0.6 μmol/kg. Based upon 1) this observation, 2) the consistency of the results of this investigation and 3) our previous expeditions, the overall precision of our total CO_2 data is estimated to be about $\pm$1.5 μmol/kg. The TCO_2 measurements listed in this report have not been corrected for the differences between the LDEO values and the SIO manometric values.

Table 1 - Results of Analyses for the SIO Reference Solutions

Batch No.	LDEO Coulometric TCO_2 (µmol/kg)	SIO Manometric TCO_2 (µmol/kg)	Difference (µmol/kg)
#25	2125.8 ± 1.4 (N=23)	2127.2 ± 1.0 (N=9)	+1.4
#30	1989.4 ± 0.9 (N=40)	1988.8 ± 1.2 (N=10)	-0.6

Fig. 3 The results of the coulometric determination of total CO_2 concentration in the SIO Certified Reference Solutions are compared with the mean value of the manometric measurements made at C. D. Keeling's laboratory, Scripps Institution of Oceanography.



2-d) Total Alkalinity Measurements:

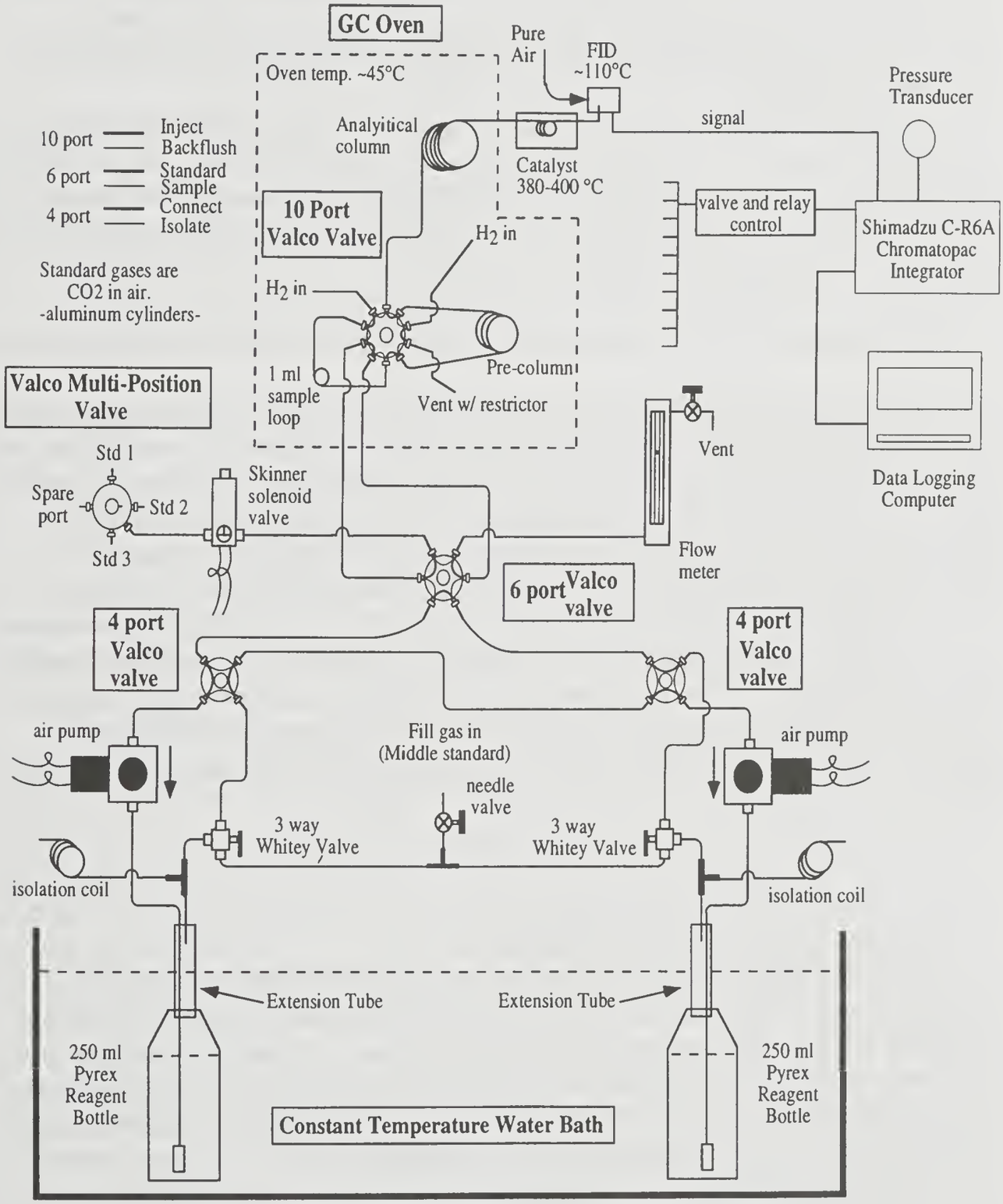
Since the limited volume of water samples did not give us enough water for alkalinity titration, a new method has been developed. A sample bottle was opened and about 30 ml of sample was withdrawn by a syringe for the initial determination of TCO_2. The bottle was sealed again and stored. Within one or two hours after the initial TCO_2 analysis, pCO_2 in the stored sample was determined and immediately after that, TCO_2 was measured again. This pair of measurements was used to compute the total alkalinity value. Because of loss of CO_2 from water to the sample bottle head space and to the equilibration system, the TCO_2 value obtained by the second analysis is not expected to be the same as the initial value that represents TCO_2 in the ocean. However, the second TCO_2 value and its corresponding pCO_2 value should yield the total alkalinity value which should be unaffected by the loss or gain in TCO_2.

The pCO_2 of a seawater sample was measured by the equilibration method described by Chipman et al. (1993). Technical details are also described in our technical report (Takahashi et al., 1998). Fig. 4 gives a schematic diagram of this system, in which two water samples may be handled simultaneously through two separate circulation loops.

Our equilibration system consists of an air circulation pump (KNF Model N05-STP) plumbed to recirculate a carrier gas through a porous plastic gas disperser which is immersed in two separate seawater samples. The carrier gas is equilibrated with the water sample after 15 minutes of recirculation. Since the partial pressure of CO_2 is sensitively affected by temperature changes, the sample bottles were kept immersed in a constant temperature water bath held at 20.0 °C for this study. The pressure of the carrier gas is kept at the ambient barometric pressure using a thin long Nylon tubing "isolation coil" branching off the circulation system, and the barometric pressure is measured with a calibrated, high precision barometer.

The analysis of the CO_2 in the equilibrated air or calibration gases was performed using a Shimadzu Mini-2 gas chromatograph equipped with a flame ionization detector. A one-ml sample loop and a pre-column and analytical column (both packed with Chromosorb 102, of 0.2 and 2.0 m lengths respectively) are used. Ultra-high purity hydrogen gas (electrolytically generated by an Aadco hydrogen generator and purified by means of diffusion through a palladium foil using an Aadco hydrogen purifier) serves as the carrier gas for the chromatographic separation of CO_2 from the other components of the air. The use of hydrogen as a carrier gas also allows the CO_2 to be converted to methane in an attached catalytic converter prior to quantification by the flame ionization detector. Unlike the method described by Weiss

Fig. 4 Schematic diagram of the pCO_2 equilibration-analysis system. Modified from Chipman et al. (1993).



(1981), our system uses a catalyst of ruthenium metal on Chromosorb W support and does not require a palladium pre-catalyst to remove oxygen from the carrier gas stream. Integration of the output signal from the gas chromatograph and control of the entire equilibration and calibration procedure is provided by means of a Shimadzu Chromatopac (Model C-R6A) computing integrator.

The equilibrated air samples taken from the headspace of the flasks are saturated with water-vapor at the temperature of equilibration and had the same pCO_2 as the water sample. By injecting the air aliquot without removal of the water vapor, the partial pressure of CO_2 was determined directly using the relationship below (Takahashi et al., 1982-a):

$$pCO_2\ (\mu atm) = [Cmeas\ (ppm)] * [Total\ pressure\ of\ equilibration\ (atm)],$$

where Cmeas is the mole fraction concentration of CO_2 in equilibrated moist air. The total pressure of the equilibrated air was measured by having the head space in the sample bottle always at atmospheric pressure which was, in turn, measured with an electronic barometer at the time each equilibrated air sample was injected into the gas chromatograph. Since water vapor was not removed from the sample, it is no need to know the water vapor pressure .

Corrections were made to account for the change in pCO_2 of the sample water due to the transfer of CO_2 to or from the water during equilibration with the recirculating air. The precision of the pCO_2 measurement for a single day has been estimated to be about $\pm$0.15 % based on the reproducibility of replicate equilibrations. However, the day-to-day reproducibility is about $\pm$ 0.5%.

2-e) Computation of the Total Alkalinity:

The alkalinity of seawater has been computed using the observed values of temperature, salinity, pCO_2 and the concentrations of total CO_2, silicate, and phosphate. In this report, the alkalinity in seawater has been computed using two different sets of apparent dissociation constants for carbonic, boric, silicic and phosphoric acids in seawater as well as two different definitions of the alkalinity, which may be named "total alkalinity" and "titration alkalinity". For the purpose of identification, we call them "Peng et al. (1987) Method" and "DOE (1994) Method" respectively. These computational methods are described below.

Peng et al. (1987) Method:

Based upon the principle of neutrality of ionic charges, the total alkalinity (TALK) in seawater is defined by:

$$TALK = \{[Na^+] + [K^+] + 2[Mg^{++}] + 2[Ca^{++}] + 2[Sr^{++}] + \ldots\ldots\} - \{[Cl^-] + [Br^-] + 2[SO_4^=] + [NO_3^-] + \ldots\ldots\} \ldots\ldots \quad \text{Eq.(1)}$$

$$= Ac + Ab + Asi + Ap + Aw \quad \ldots\ldots\ldots\ldots \quad \text{Eq.(2)}$$

where

Ac = Carbonate alkalinity = $[HCO_3^-] + 2[CO_3^=]$ ..... Eq.(3)

Ab = Borate alkalinity = $[H_2BO_3^-]$ ..... Eq.(4)

Asi = Silicate alkalinity = $[H_3SiO_4^-]$ ..... Eq.(5)

Ap = Phosphate alkalinity = $[H_2PO_4^-] + 2[HPO_4^=] + 3[PO_4^{-3}]$ .... Eq.(6)

Aw = Water alkalinity = $[OH^-] - [H^+]$ ..... Eq.(7)

The quantities in [ ] indicate the concentration of respective ionic species including those of charged or neutral complex ion species (for sample, $CaHCO_3^+$ and $CaCO_3^\circ$). In the case of $[H^+]$, it includes the [HF] and $[HSO_4^-]$ (see Takahashi, 1982-b, and Peng et al., 1987).

The total alkalinity is the number of anion charges needed to neutralize the excess cation charges of strong electrolytes (or whose concentrations do not depend on hydrogen ion activity) (see Eq.(1)); or it is the total number of cation charges required to bring anionic species of weak acids to neutrally charged species (see Eq. (2)). The effects of organic acids are neglected.

The total concentration of borate (TB) has been assumed to be proportional to salinity: TB (μmol/kg) = 410.6 *(Sal/35). The borate alkalinity ranges between about 40 μeq/kg for deep waters and 100 μeq/kg for surface waters. Since the silicate concentration may be as high as 150 μmol/kg in deep waters, the silicate alkalinity is as high as 6 μeq/kg for deep water but it is negligibly small for surface waters. The phosphate alkalinity ranges from 0.5 μeq/kg for surface waters to about 5 μeq/kg in deep waters. The following solubility and apparent dissociation constants of acid in seawater were used; solubility of CO_2 gas in seawater formulated by Weiss (1974); Merhbach et al. (1973) for carbonic acid; Lyman (1956) for boric acid; Kester and Pytkowicz (1967) for phosphoric acid; Sillen and Martell (1964) for silicic acid; and Millero (1979) and Culberson and Pytkowicz (1973) for water. The expressions used to compute these constants as a function of temperature and salinity and the computational scheme are described in Peng et al. (1987). A copy of computer program used is attached in Table 2.

Table 2 BASIC computer program used for the calculation of the total alkalinity in seawater with the dissociation constants for carbonic, boric, silicic and phosphoric acids parameterized according to Peng et al. (1987).

```
REM FILE NAME = TALK.BAS
REM THIS IS TO COMPUTE TALK (uEQ/KG) FROM TCO2 AND PCO2 USING
REM MEHRBACH K1 AND K2 FOR CARBONIC ACID, LYMAN KB FOR BORIC ACID,
REM WEISS CO2 SOLUBILITY, KESTER & PYTKOWICZ KP2 AND KP3 FOR PHOSPHORIC
REM ACID, SILLEN & MARTEL KSI FOR SILICIC ACID, AND MILLERO'S
FORMULATION REM OF KW.

DEFDBL A-Z
100
CLS
LINE INPUT "Enter sample number (TALK.BAS):"; SP$
INPUT "Enter temperature in C    : ", Tc
INPUT "Enter salinity in o/oo    : ", SA
INPUT "Enter Total CO2 in umol/kg  : ", CT
INPUT "Enter pCO2 in uatm        : ", pC
INPUT "Enter silica in umol/kg    : ", Si
INPUT "Enter phosphate in umol/kg  : ", Po

Tk = Tc + 273.15
CT = CT * .000001
pC = pC * .000001
Si = Si * .000001
Po = Po * .000001

REM COMPUTE CO2 SOLUBILITY IN SEAWATER IN MOLES/ATM.KG.SW
k0 = EXP(-60.2409 + 9345.17 / Tk + 23.3585 * LOG(Tk / 100)
        + SA * (.023517 - 2.3656E-04 * Tk + 4.7036E-07 * Tk * Tk))

REM COMPUTE K1 AND K2 OF CARBONIC ACID IN SEAWATER
K1 = EXP(2.302585# * (13.7201 - .031334 * Tk - 3235.76 / Tk - .000013 * SA * Tk
        + .1032 * SQR(SA)))
K6 = -5371.9645# - 1.671221# * Tk - .22913 * SA + 128375.28# / Tk
        + 8.0944E-04 * Tk * SA - 2.136 * SA / Tk
K7 = -18.3802 * LOG(SA) + 2194.3055# * LOG(Tk) + (5617.11 / Tk) * LOG(SA)
K2 = EXP(K7 + K6 * 2.302585#)

REM COMPUTE KB,KP2 AND KP3
KB = EXP(2.302585# * (-9.26 + .00886 * SA + .01 * Tc))
K3 = EXP(-9.039 - 1450 / Tk)
K4 = EXP(4.466 - 7276 / Tk)
K5 = 4E-10
```

Table 2 - (Continued)

```
REM COMPUTE DISSOCIATION CONSTANT FOR WATER
KW = EXP(148.9802# - 13847.26# / Tk - 23.6521 * LOG(Tk) + (-79.2447 + 3298.72 / Tk
        + 12.0408 * LOG(Tk)) * SQR(SA) - .019813 * SA)

REM ACTIVITY OF HYDROGEN ION IN SEAWATER BASED ON TAKAHASHI
FORMULATION OF CULBERSON & PYTKOWICZ DATA
FH = 1.29 - .00204 * Tk + .000461 * SA * SA - 1.48E-06 * SA * SA * Tk

REM TOTAL BORON IS BASED ON CULKIN
Tb = .0004106 * SA / 35

REM COMPUTE AH USING PCO2 AND TCO2
CU = k0 * pC
h = (K1 + SQR(K1 * K1 + 4 * K1 * K2 * (CT / CU - 1))) / (2 * (CT / CU - 1))
pH = -LOG(h) / 2.30258

REM COMPUTE TOTAL ALKALINITY
AC = k0 * pC * (K1 / h + 2 * K1 * K2 / (h * h))
AB = KB * Tb / (h + KB)
ASi = K5 * Si / (h + K5)
AP = Po * (1 / (1 + K3 / h + K3 * K4 / (h * h)) + 2 / (1 + h / K3 + K4 / h)
        + 3 / (1 + h / K4 + h * h / (K3 * K4)))
AW = KW * FH / h - h / FH
AT = AC + AB + ASi + AP + AW
CB = K1 * CU / h
CC = K2 * CB / h

PRINT
PRINT "TALK (ueq/kg) = "; AT * 1000000!
PRINT "H2CO3 (umol/kg) = "; CU * 1000000!
PRINT "HCO3- (umol/kg) = "; CB * 1000000!
PRINT "CO3=  (umol/kg) = "; CC * 1000000!
PRINT "Carbonate Alk (ueq/kg) = "; AC * 1000000
PRINT "Borate Alk (ueq/kg)    = "; AB * 1000000
PRINT "Silicate Alk (ueq/kg) = "; ASi * 1000000
PRINT "Phosphate Alk (ueq/kg) = "; AP * 1000000
PRINT "Water Alk (ueq/kg)     = "; AW * 1000000
PRINT USING "K0 = +#.########^^^^      K1 = +#.########^^^^"; k0, K1
PRINT USING "K2 = +#.########^^^^      KB = +#.########^^^^"; K2, KB
PRINT USING "KW = +#.########^^^^      fH = +#.########^^^^"; KW, FH
PRINT USING "aH = +#.########^^^^      pH = ##.########"; h, pH
PRINT
INPUT "Press <ENTER> to continue"; A$
GOTO 100
```

DOE (1994) Method:

The results of modern measurements of various dissociation constants of acids in seawater have been assembled by Dickson and Goyet in a Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water, (DOE, 1994). On the basis of the so-called "proton condition" (Butler, 1964), the "titration" alkalinity has been defined by Dickson (1981) as the amount of acid needed to reduce the pH of seawater to 3.5. While it is expressed by equations identical to Eqs. (1) and (2), the definition of phosphate alkalinity is slightly different from Eq. (6) and is instead:

$$Ap = \text{Phosphate alkalinity} = [HPO_4^{=}] + 2[PO_4^{-3}] \quad \text{Eq.(8)}$$

In a range of normal open ocean seawater, the values for phosphate alkalinity computed using Eq. (6) are greater than those computed using Eq. (8) by 2 μeq/kg or less. Therefore, the computed "total" alkalinity is generally greater than the "titration" alkalinity by only 2 μeq/kg or less. the effects of organic acids are neglected.

The "titration" alkalinity values listed in this report have been computed using the following sources of constants; the solubility of CO_2 in seawater formulated by Weiss (1974); the first and second dissociation constants for carbonic acid in seawater formulated by Dickson and Millero (1987) based on the results of Mehrbach et al. (1973); the first dissociation constant for boric acid by Dickson (1990); the first and second dissociation constants for phosphoric acid formulated by Millero (1974) based on the work of Kester and Pytkowicz (1967) and Dickson and Riley (1979); the dissociation constant for water by Dickson and Riley (1979); and the dissociation constant for silicic acid by Sjoberg et al., (1981) and Baes and Mesmer, (1977). A copy of computer program used is shown in Table 3.

Table 3 BASIC computer program used for the calculation of the total alkalinity in seawater with the dissociation constants for carbonic, boric, silicic and phosphoric acids parameterized according to DOE Handbook (1994).

```
REM FILE NAME = TALK2DE4M.BAS
REM THIS IS TO COMPUTE TALK (ueq/kg) FROM TCO2 AND pCO2 USING
REM THE DISSOCIATION CONSTANTS FOR CARBONIC ACID BY MEHRBACH ET AL.
REM (1973) FORMULATED BY DICKSON AND MILLERO (1987) USING THE SW PH
REM SCALE; FOR BORIC ACID BY DICKSON (1990); THAT FOR WATER BY DICKSON
REM AND RILEY (1979); THOSE FOR PHOSPHORIC AND SILICIC ACIDS ARE
REM FROM THE DOE HANDBOOK VERSION 2.0 ARE USED.
REM THE DEFINITION OF THE TOTAL ALKALINITY IS BY DICKSON (1981).
REM THE SEAWATER PH SCALE IS USED THROUGHOUT THE COMPUTATION.
REM 3/16/96 BY TARO TAKAHASHI
DEFDBL A-Z
100 :
CLS
LINE INPUT "Enter sample number (TALKDE4M.BAS/MBD): "; SP$
INPUT "Enter temperature in C        : ", Tc
INPUT "Enter salinity in o/oo        : ", SAL
INPUT "Enter Total CO2 in umol/kg    : ", CT
INPUT "Enter pCO2 in uatm            : ", CP
INPUT "Enter silica in umol/kg       : ", SIT
INPUT "Enter phosphate in umol/kg    : ", PT
TK = Tc + 273.15
CT = CT * .000001
CP = CP * .000001
SIT = SIT * .000001
PT = PT * .000001

REM COMPUTE CO2 SOLUBILITY IN SEAWATER (WEISS, 1974) IN MOLES/ATM.KG.SW
KC01 = (.023517# - .00023656# * TK + .00000047036# * TK * TK)
KC02 = -60.2409# + 9345.17# / TK + 23.3585# * LOG(TK / 100)
KC0 = EXP(KC02 + SAL * KC01)

REM COMPUTE K1 AND K2 OF CARBONIC ACID IN SEAWATER BY MEHRBACH ET AL.
REM (1973) FORMULATED BY DICKSON AND MILLERO (1987) WITH THE SW PH
REM SCALE IS USED.
KC11 = .0118 * SAL - .000116 * SAL * SAL
KC10 = 62.008 - 3670.7 / TK - 9.7944 * LOG(TK)
KC1 = EXP(2.302585# * (KC10 + KC11))

KC21 = -1394.7 / TK - 4.777 + .0184 * SAL - .000118 * SAL * SAL
KC2 = EXP(2.302585# * KC21)

REM CONVERSION FACTOR (CPH) FROM THE (H)t SCALE TO THE SEAWATER PH
REM SCALE
```

Table 3 - (Continued)

```
REM FLT = Total Concentration of Fluorine =  (HF) + (F-)
REM SPT = TOTAL SULFATE CONC.
SPT = .02824 * SAL / 35
FLT = .00007 * SAL / 35
IOS = .7223 * SAL / 35
KHFo = EXP(1590.2 / TK - 12.641 + 1.525 * SQR(IOS))
pEKSO4o = (6.3451 - 647.58 / TK - .019085 * TK + .5208 * SQR(IOS))
KSO4o = EXP(2.302585# * pEKSO4o)
KHFs = KHFo * (1 + SPT / KSO4o)
CPH = 1 + FLT / KHFs

REM COMPUTE KB (DICKSON, 1990)
KB14 = .053105# * SQR(SAL) * TK
KB13 = (-24.4344# - 25.085 * SQR(SAL) - .2474 * SAL) * LOG(TK)
KB12 = 148.0248# + 137.1942# * SQR(SAL) + 1.62142# * SAL
KB11 = (-.0996 * SAL + 1.728 * SQR(SAL) - 77.942) * SAL - 2890.53 * SQR(SAL)
KB = CPH * EXP((-8966.9# + KB11) / TK + KB12 + KB13 + KB14)

REM COMPUTE DISSOCIATION CONSTANTS FOR PHOSPHORIC ACID (MILLERO, 1974)
REM THIS IS A COMPOSITE OF KESTER & PYTKOWICZ (1967), DICKSON & RILEY
REM (1979), AND JOHANSSON & WEDBORG (1979).
KP11 = SAL * (-.01844 - .65643 / TK) + SQR(SAL) * (.69171 - 106.736 / TK)
KP1 = CPH * EXP(115.54 - 4576.752# / TK - 18.453 * LOG(TK) + KP11)
KP21 = SAL * (.37335 / TK - .05778) + SQR(SAL) * (1.3566 - 160.34 / TK)
KP2 = CPH * EXP(172.1033# - 8814.715# / TK - 27.927 * LOG(TK) + KP21)
KP31 = SAL * (-.09984 - 44.99486# / TK)
KP32 = SQR(SAL) * (17.27039# / TK + 2.81197#)
KP3 = CPH * EXP(-18.126 - 3070.75 / TK + KP31 + KP32)

REM SILICIC ACID DISSOCIATION CONSTANT (SJOBERG ET AL,1981; BAES &
REM MESMER (1977)
KSI1 = IOS * (IOS * (.07871 - 12.1652# / TK) + 188.74 / TK - 1.5998#)
KSI2 = SQR(IOS) * (3.5913 - 458.79 / TK)
KSI = CPH * EXP(117.4 - 8904.2 / TK - 19.334 * LOG(TK) + KSI1 + KSI2)

REM COMPUTE DISSOCIATION CONSTANT FOR WATER BY DICKSON & RILEY (1979)
REM  IN THE SW PH SCALE AND IN MOLE/KG-SW.
KW1 = -3441! / TK - 2.241 + .09415 * SQR(SAL)
KW = EXP(2.302585# * KW1)

REM TOTAL BORON IS BASED ON CULKIN
BT = .0004106 * SAL / 35

REM COMPUTE Hsw using TCO2 and pCO2
CU = KC0 * CP
```

Table 3 - (Continued)

```
Hsw = (KC1 + SQR(KC1 * KC1 + 4 * KC1 * KC2 * (CT / CU - 1))) / (2 * (CT / CU - 1))

REM COMPUTE TOTAL ALKALINITY
AB = BT / (1 + Hsw / KB)
ASI = SIT / (1 + Hsw / KSI)
APD = Hsw * Hsw * Hsw + KP1 * Hsw * Hsw + KP1 * KP2 * Hsw + KP1 * KP2 * KP3
AP0 = PT * Hsw * Hsw * Hsw / APD
AP1 = PT * KP1 * Hsw * Hsw / APD
AP2 = PT * KP1 * KP2 * Hsw / APD
AP3 = PT * KP1 * KP2 * KP3 / APD
AP = AP2 + 2 * AP3 - AP0
AW = KW / Hsw - Hsw
AC = KC0 * CP * (KC1 / Hsw + 2 * KC1 * KC2 / (Hsw * Hsw))

AT = AC + AB + ASI + AP + AW

CB = KC1 * CU / Hsw
CC = KC2 * CB / Hsw

PHsw = -LOG(Hsw) / 2.30258
Hf = Hsw / (1 + (SPT / KSO4o) + (FLT / KHFs))
PHf = -LOG(Hf) / 2.30258

PRINT "TALK (ueq/kg)              = "; AT * 1000000!
PRINT "(CO2)aq (umol/kg)          = "; CU * 1000000!
PRINT "HCO3- (umol/kg)            = "; CB * 1000000!
2PRINT "CO3=  (umol/kg)           = "; CC * 1000000!
PRINT "Carbonate Alkalinity (ueq/kg)  = "; AC * 1000000
PRINT "Borate Alkalinity (ueq/kg)     = "; AB * 1000000
PRINT "Silicate Alkalinity (ueq/kg)   = "; ASI * 1000000
PRINT "Phosphate Alkalinity (ueq/kg)  = "; AP * 1000000
PRINT "Water Alkalinity (ueq/kg)      = "; AW * 1000000
PRINT "pH)sw = "; PHsw, "(H)sw = "; Hsw
PRINT
INPUT "Press <ENTER> to continue"; A$
GOTO 100
```

2-f) Precision of the Alkalinity Measurements:

As seen in the attached data tables, the alkalinity values obtained using the DOE (1994) scheme are consistently greater than those computed using the Peng et al. (1987) scheme by about 7 μeq/kg. However, within each set of computed values, the precision of alkalinity values are estimated to be ± 2 ueq/kg on the basis of deep water values.

Unfortunately, the alkalinity values for the SIO Reference Solutions by the acid titration method of A. G. Dickson were not available at the time when we made the paired pCO_2-TCO_2 measurements. Although we measured TCO_2 in the Reference Solutions for comparison as discussed in Section 2-c), we did not make any pCO_2 measurement for Batches 25 and 30 of Reference Solutions. Therefore, our computed alkalinity values cannot be confirmed by comparison with the titration values. However, pCO_2 values in other batches of the SIO Reference Solutions were measured, and the total alkalinity values in these solutions were computed. The results are summarized in Table 4 and show that the computed alkalinity values using Peng et al. (1987) and DOE (1994) schemes are repsecitvely lower by about 3.5 and 10 μeq/kg than Dickson's titration values. The mean difference between Dickson's titration values and those obtained by Peng et al. scheme is within two standard deviations of the respective measurements.

2-g) Computation of the Apparent Oxygen Utilization:

The Apparent Oxygen Utilization (AOU) value was computed and is listed in the data tables of report. The relationships between TCO_2 and AOU are explored briefly in the following section.

The AOU value was computed by subtracting the measured oxygen concentration from the saturation value computed at the potential temperature of water and 1 atm total pressure using the following expression based on the data of Murray and Riley (1969):

$$\ln(O_2 \text{ in } \mu\text{mol/kg}) = -173.9894 + 255.5907(100/TK) + 146.4813 \ln(TK/100) - 22.2040(TK/100) + Sal\,[-0.037362 + 0.016504(TK/100) - 0.0020564(TK/100)^2],$$

where TK is temperature in °K and Sal is salinity in the Practical Salinity scale (PSS-78).

Table 4 Comparison of the titration alkalinity values in the SIO Reference Solutions determined by A. G. Dickson, SIO, with those computed using paired pCO2-TCO2 measurements. The SIO Titration Alkalinity values were determined by A. G. Dickson, and the SIO TCO2 values were measured by C. D. Keeling of SIO using the manometric method. The pCO2 in Reference Solutions were determined at 4.0 C for the Batch 33 and 34 solutions and at 20.0 C for the Batch 36 solutions. The numbers in (N=) indicate the number of repeated measurements, and +/- indicates one standard deviation.

Batch No.	SIO Titration Alkalinity (ueq/kg)	SIO TCO2 Conc. (umol/kg)	Computed Alkalinity from pCO2 and TCO2 Peng et al. (1987) (ueq/kg)	DOE (1994) (ueq/kg)	Measured pCO2 (uatm)	Alkalinity SIO-Peng (ueq/kg)	Differences SIO-DOE (ueq/kg)
33	2234.92 +/-0.44 (N = 35)	2009.85 +/-0.85 (N = 11)	2231.8 +/-2.2	2224.6 +/-2.2	228.6 +/-2.6 @ 4.0C (N = 20)	3.1	10.3
34	2284.35 +/-0.86 (N = 34)	2061.52 +/-1.62 (N = 15)	2280.8 +/-1.3	2273.1 +/-1.3	247.4 +/-1.6 @ 4.0C (N = 20)	3.6	11.3
36	2283.83 +/-0.77 (N = 25)	2050.21 +/-0.72 (N = 10)	2280.3 +/-0.8	2274.1 +/-0.8	470.2 +/-1.2 @ 20.0C (N = 31)	3.5	9.7

3. DISTRIBUTION OF THE MEASURED PROPERTIES

3-a) Potential Temperature-Salinity Relationships:

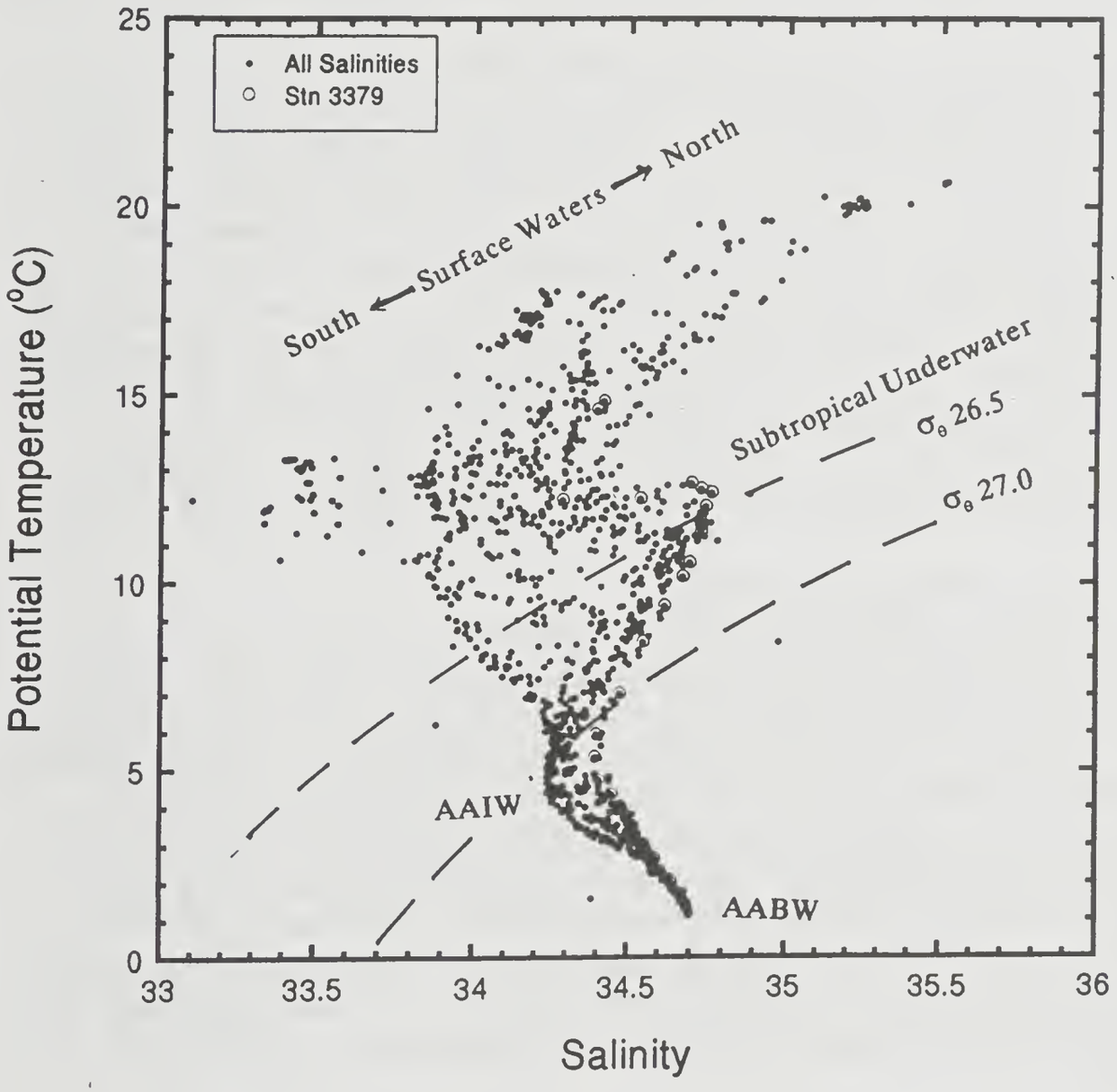
Potential temperature-salinity relationships observed during the SONNE # 102 Cruise are shown in Fig. 5, and the major water masses present in the study area are identified in order to aid our understanding of the distribution of CO_2 and associate quantities in water columns. Two isopycnal lines (σ_θ = 26.5 and 27.0) are shown with dashed lines.

The sea surface temperatures in the study area range from about 11°C near 43°S to about 21°C near 28°S (marked "Surface Waters in Fig. 5). In the northern portion of the study areas, the seasonal surface layer is underlain at about 200 meters depth by a warm saline "Subtropical Underwater" (about 12°C, about 34.7 salinity with a sigma-θ density of about 26.5) which originates from coastal areas where the evaporation rate exceeds the precipitation rate. The signals for this saline water are stronger in the northern coastal stations, and are most intense at Station 3379 located at the northeastern corner of the study area close to the coast (see Fig. 1). The data representing Station 3379 are circled in Fig. 5. The oxygen concentrations in this layer are very low (as low as 6 μmol/kg was observed at 300 meters, Station 3420), and the total CO_2 values are correspondingly very high (as high as 2265 μmol/kg at Station 3382).

Further down the water column, below about 700 meters, a low salinity water of a sigma-θ density of about 27 is present. This represents the Antarctic Intermediate Water (AAIW) with higher oxygen and lower CO_2 concentrations. Its signal increases toward southerly stations in the study area, and are weakest at Station 3379 located at the northeastern corner of the study area (see the circled data points in Fig. 5). The AAIW causes local minima in salinity, TCO_2 and phosphate, and a local maximum in oxygen, which are centered around 600 meters.

Below the AAIW, the density increases smoothly to those value for Antarctic Bottom Water (AABW). Many properties are nearly constant below 1500 meters to the bottom of the ocean about 5000 meters deep.

Fig. 5 Potential temperature-salinity relationships observed during the SONNE # 102 Cruise. The data points at Station 3379, which is located at the northeastern corner of the study area (see Fig. 1), are circled.



3-b) Vertical Distribution of TCO_2:

Fig. 6 shows a nested plot for the 17 depth profiles for TCO_2 obtained during this study. Each profile is offset by 50 µmol/kg. The station number and the TCO_2 value in the deepest sample are indicated at the bottom end of each profile. The deepest profile was observed down to about 5000 meters at Station 3348 in the Chile Trench. Clearly observable are a) TCO_2 maxima centered around 300 meters, which coincide with the salinity maxima and oxygen minima; b) TCO_2 minima centered around 600 meters, which represent AAIW. All profiles are superimposed in Fig. 7, in which the values obtained at Station 3346 located near the center of the study area are circled. The deep water values below about 1700 meters range between 2320 µmol/kg and 2290 µmol/kg. A broad maximum centered around 2000 meters is best visible at the 3700 meter-deep profile at Station 3331 located at the southwestern corner of the study area. The TCO_2 maximum (2300 umol/kg) represents the core of the southward flowing deep water returning from the North Pacific Ocean, and this is undercut by the AABW which has a lower TCO_2 concentration of 2260 umol/kg (Takahashi et al. 1998). The deep Chile Trench water observed at Station 3348 does not appear to be affected strongly by the low TCO_2 AABW.

3-c) TCO_2 and Oxygen Relationship:

The relationship between the TCO_2 and oxygen concentration are governed primarily by mixing between water masses as shown in Fig. 8. The oxygen concentration is expressed in terms of the Apparent Oxygen Utilization (AOU) computed using the method described in Section 2-g). The warm saline Subtropical Underwater (200 m - 400 m) is characterized by high AOU (i. e. very low oxygen concentrations) and high TCO_2 values, while the AAIW (centered around 600 meters) has lower AOU and TCO_2 values. Fig. 8 also shows that the AOU-TCO_2 trend observed between 1500 meters and 5000 meters appears to be bowed with the highest TCO_2 values around 2500 meters. This non-linear relationship may be partly caused by the oxidation of high organic debris raining down from the overlying high productivity surface waters.

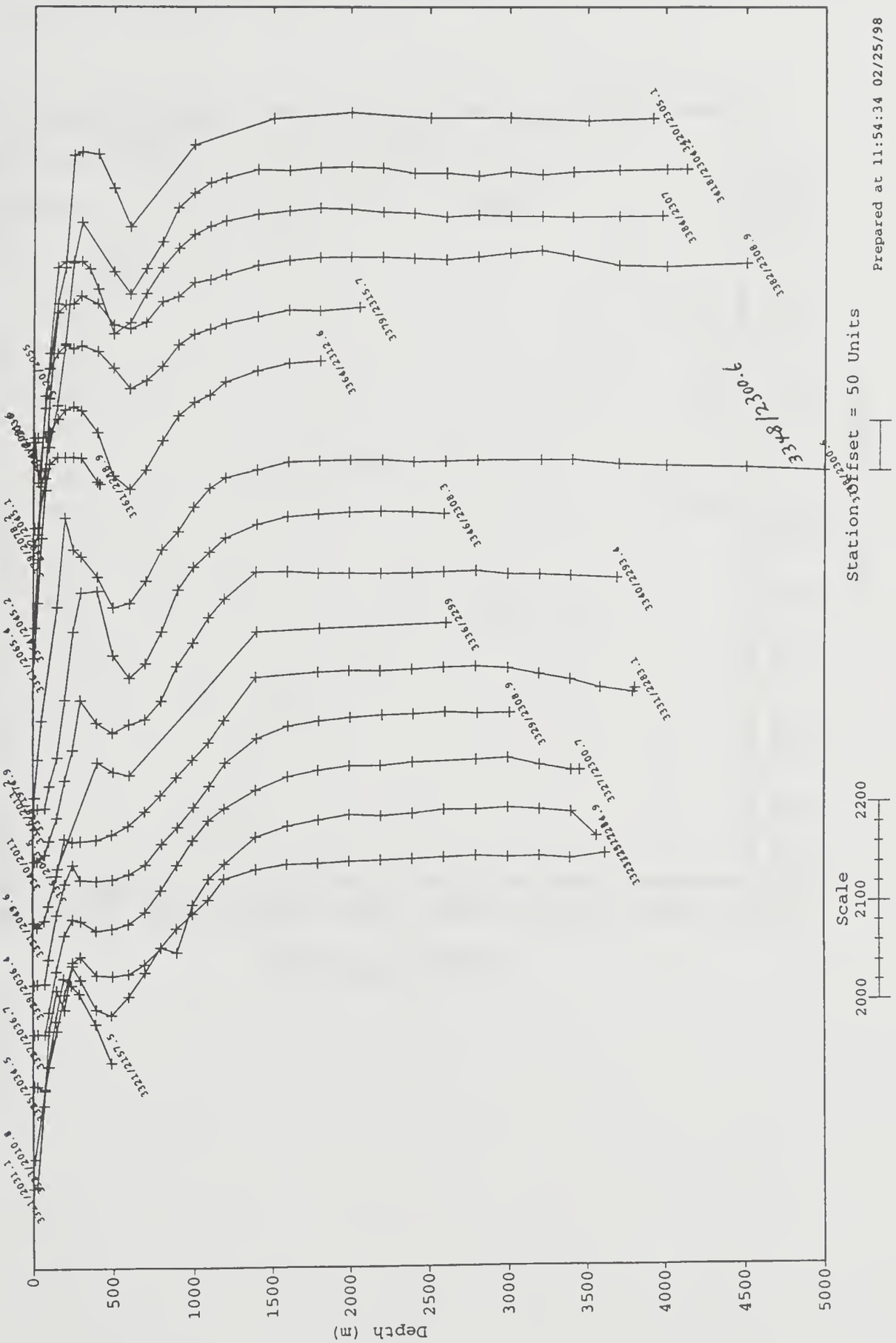


Fig. 6 A nested plot for the 17 depth profiles for TCO_2 obtained during this study. Each profile is off-set by 50 µmol/kg. The station number and the TCO_2 value in the deepest sample are indicated at the bottom end of each profile.

Fig. 7 Vertical distribution of TCO_2 in the study area. The values obtained at Station 3346 located near the center of the study area are circled.

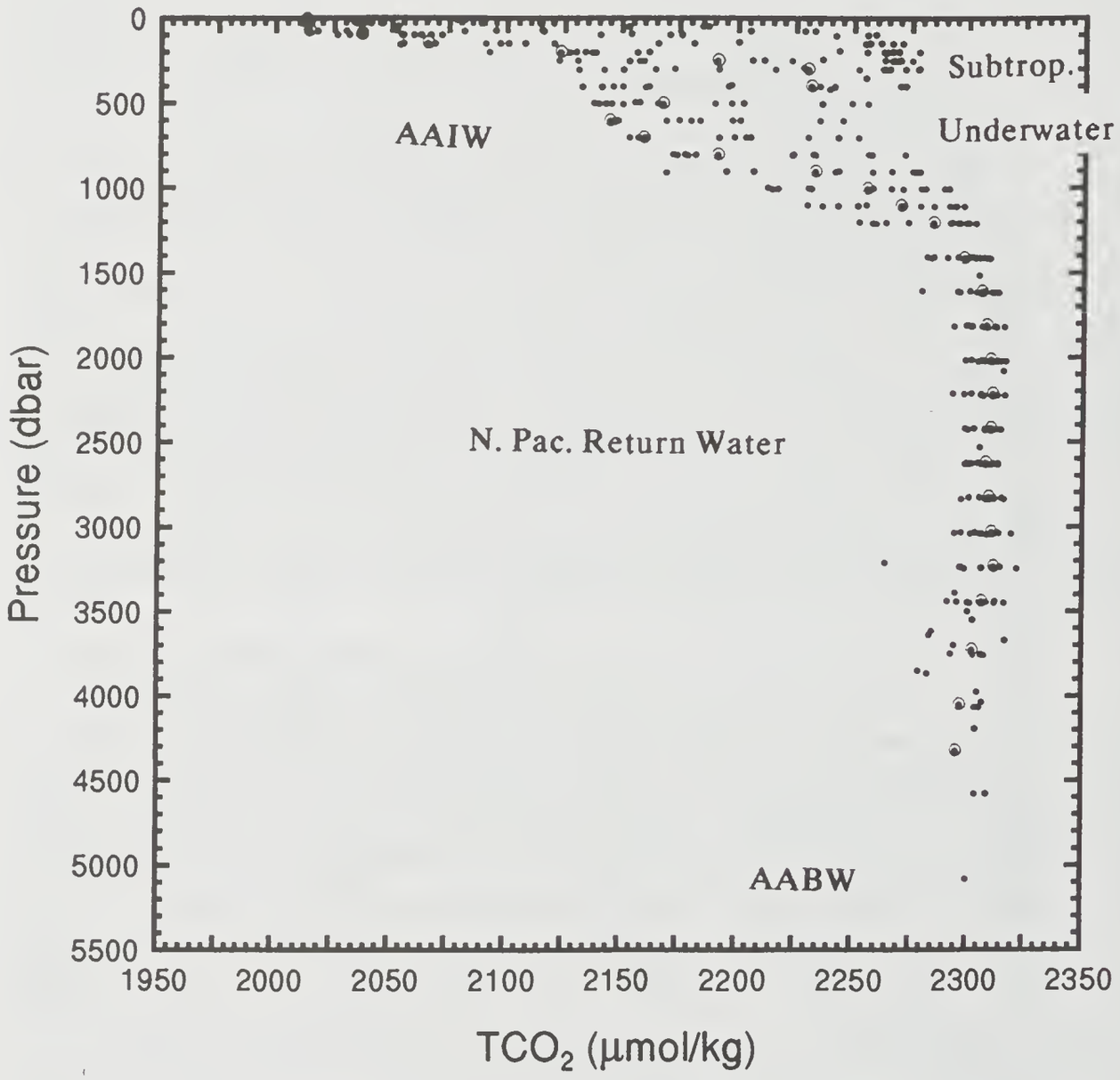
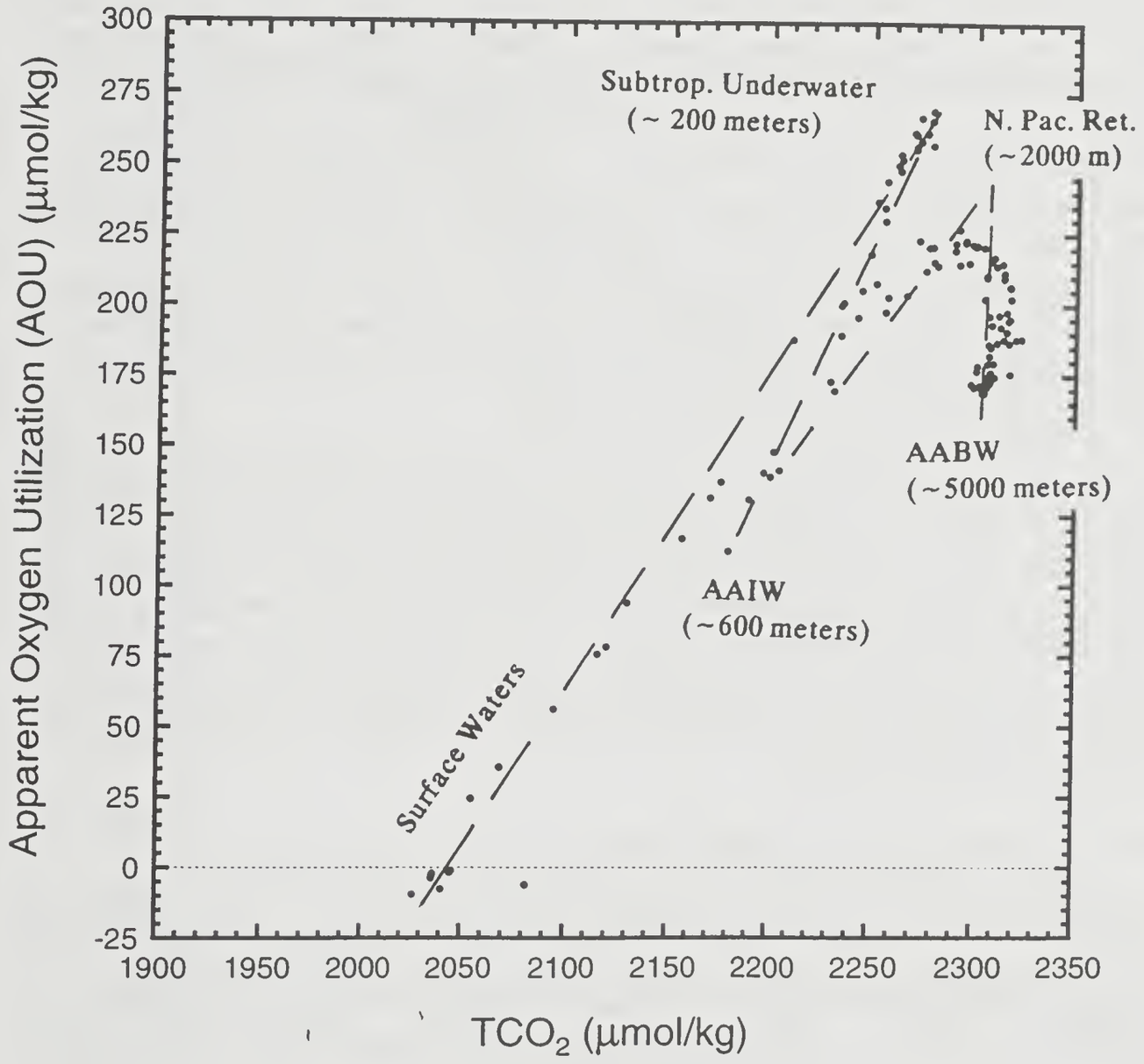


Fig. 8 The relationships between TCO_2 and Apparent Oxygen Utilization (AOU) observed in the study area.



3-d) Alkalinity and Salinity Relationship:

The vertical distribution of alkalinity is shown in Fig. 9. The Subtropical Underwater exhibits minor local maxima centered around 200 meters, and AAIW exhibits minor local minima centered around 600 meters. Below this depth, the alkalinity increases smoothly to the floor of the ocean about 5000 meters. The data (circled in Fig. 9) from Station 3331 which is located at the southwestern corner of the study area (see Fig. 1) show a broad alkalinity maximum centered around 3000 meters. This maximum is due mainly to the fact that high alkalinity and high TCO_2 waters returning from the North Pacific Ocean at a depth range of 2000 ~ 3000 meters are undercut by the AABW which contains lower alkalinity and lower TCO_2. The alkalinity data obtained at the Chile Trench (Station 3348) down to about 5000 meters indicate that the trench is filled mainly with North Pacific return water and does not appear to receive a large influx of low alkalinity AABW.

The alkalinity-salinity plot (Fig. 10) shows that the alkalinity in the study area is governed primarily by mixing of water masses. The surface water trend may be approximated by a straight line passing through the origin (the dashed line in Fig. 10), indicating that the surface water alkalinity is regulated primarily by evaporation and precipitation of water. Close proximity of the Subtropical Underwater with the surface water trend support its nearby origin. The effects of AABW (observed at Station 3331) are clearly depicted by the sharp hook representing the chemical signature of AABW, i. e. higher salinity and lower alkalinity values.

3-e) Alkalinity and TCO_2 Relationship:

The relationships between the total alkalinity and total CO_2 concentration observed during this study are shown in Fig. 11. The relationship is governed primarily by mixing between water masses. The data trends observed between AAIW (about 600 meters) and the North Pacific return water (3000 meters) appear to be bowed to right. This deviation from a straight line relationship representing mixing between two water masses indicates that CO_2 was added by the oxidation of organic debris and/or by the dissolution of $CaCO_3$ (see the vector diagram in Fig. 11) in the water column. Since relatively few oxygen determinatioins are available (see Fig. 8) in this depth range, it is not possible to differentiate the effect of the oxidation of organic debris from that of the $CaCO_3$ dissolution.

The data from southwestern stations (e. g. Station 3331) show the effect of the AABW. Although this trend appears to be consistent with the effect of $CaCO_3$ dissolution, it may be due simply to the effect of mixing, and cannot be uniquely attributed to the $CaCO_3$ dissolution in water columns.

Fig. 9 Vertical distribution of the total alkalinity in the study area. The values obtained at Station 3331 located at the southwestern corner of the study area and those obtained at Station 3379 located at the northeastern corner of the study area are circled.

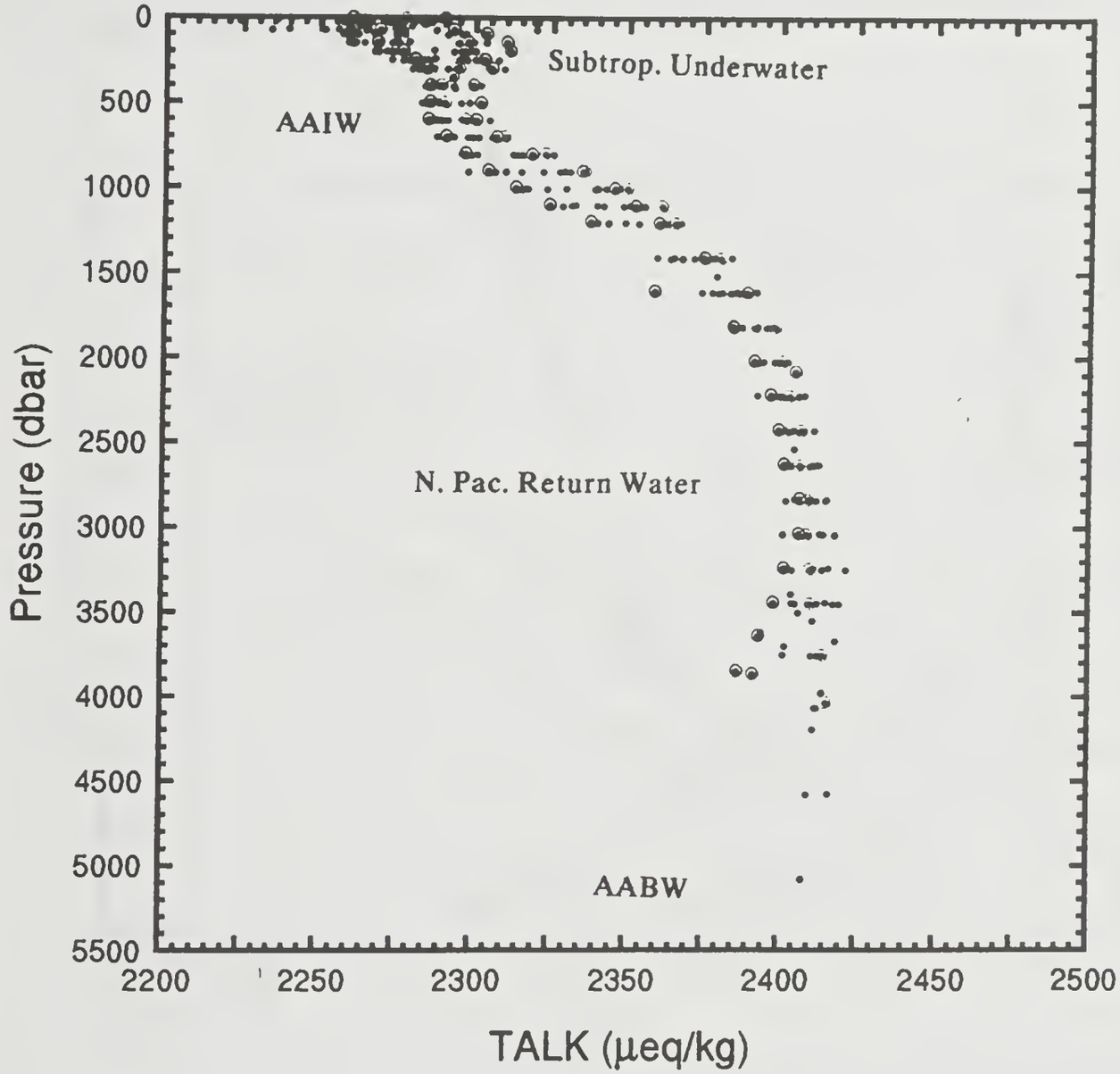


Fig. 10 The relationships between the total alkalinity and salinity. The dashed line indicates the trend observed in surface waters.

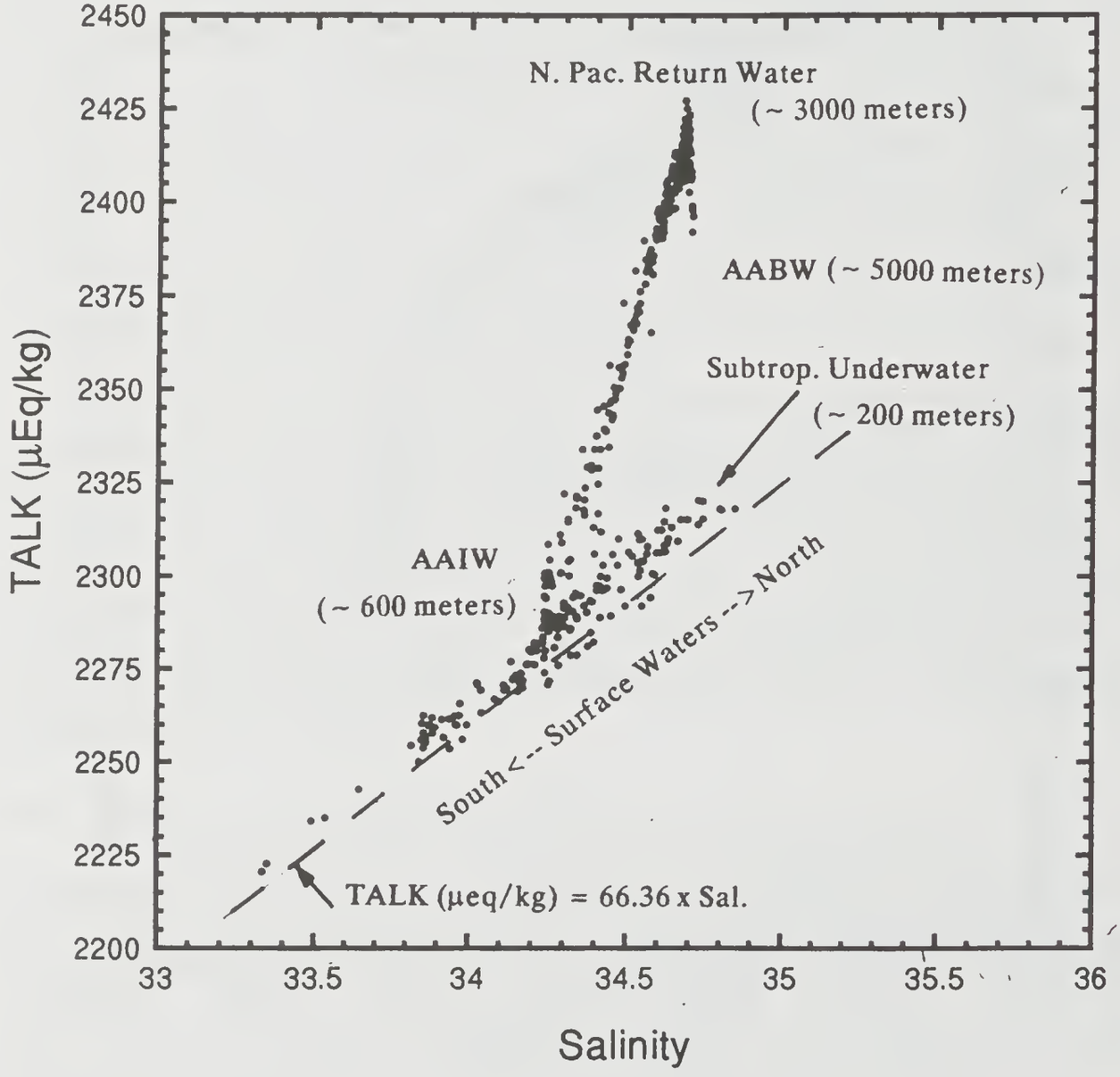
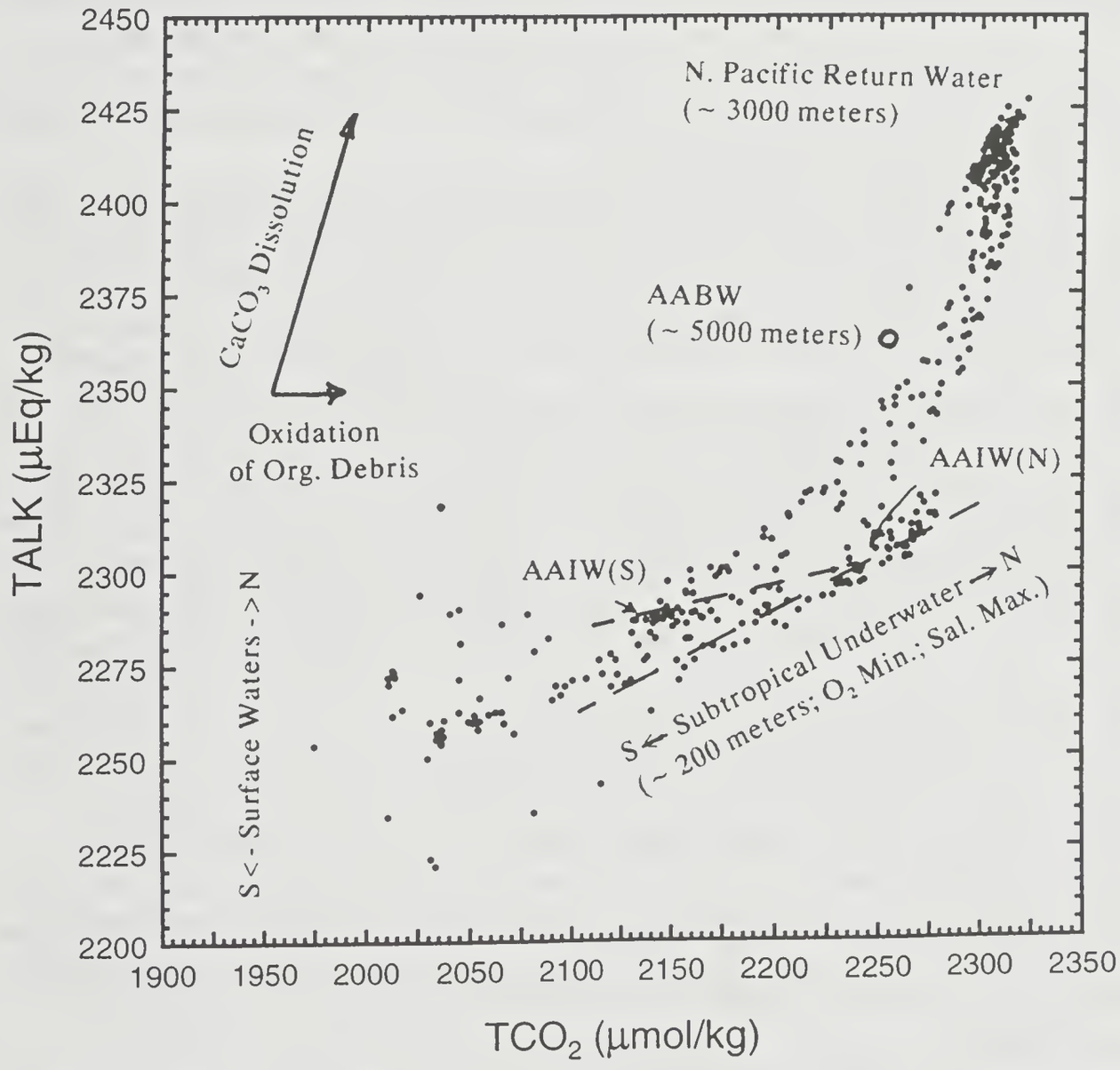


Fig. 11 The relationship between the total alkalinity and total CO_2 concentration observed during this study. AAIW(N) and AAIW(S) = Antarctic Intermediate Water observed respectively near the northern and southern sectors of the study area; and AABW = Antarctic Bottom Water (the observed end member is indicated by an open circle). Dashed lines indicate general trends between water masses or within a water mass.



4. SUMMARY AND CONCLUSIONS

1) During the SONNE Cruise 102, May-June, 1995, in the eastern South Pacific Ocean, 420 water samples were collected and shipped to the land-based laboratory of Lamont-Doherty Earth Observatory for determinations of total CO_2 concentration and total alkalinity. This report describes the methods used and lists the results of determinations of these quantities in 408 samples.

2) The total CO_2 concentration (TCO_2) was determined by coulometric titration (Chipman et al., 1993) with a precision (reproducibility) of $\pm$ 1.0 μmol/kg. A comparison of our coulometric measurements with the manometric measurements of C. D. Keeling of the Scripps Institution of Oceanography for SIO Reference Solutions indicates that our results are within 1.4 μmol/kg of the manometric values.

3) The total alkalinity was determined by a new method. The total CO_2 concentration in a water sample was determined immediately after pCO_2 was measured in a sample bottle at 20.0 °C, and these values were used to compute total alkalinity. Two different sets of the dissociation constants for carbonic, boric, phosphoric and silicic acids in seawater were used for the computation, and the two sets of resulting alkalinity values are presented in the data tables. The precision of the computed alkalinity values in each set has been estimated to be about $\pm$ 2 μeq/kg on the basis of deep water values. However, the alkalinity values computed using the dissociation constants listed in the DOE Handbook of Methods for Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water (1994) are systematically smaller by about 7 μeq/kg than those computed using the dissociation constants selected by Peng et al. (1987). Since alkalinity values for the SIO Certified Reference Solutions were not available at the time when this study was made, we did not measure the alkalinity for the Reference Solutions using our new method, and hence could not directly confirm the accuracy of our computed alkalinity values. However, pCO_2 measurements made other batches of Reference Solutions suggest that the alkalinity values computed by Peng et al. (1987) and DOE (1994) schemes are smaller by 3.5 μeq/kg and 10 μeq/kg respectively than Dickson's titration values. The difference between Dickson's titration values and Peng et al. scheme is within two standard deviations of the respecitive measurements.

4) The distribution of the total alkalinity and TCO_2 concentration in water columns are governed primarily by mixing of major water masses which include the Subtropical Underwater (centered around 200 meters), AAIW (centered around 600 meters), North Pacific Return Water (centered around 2500 meters) and AABW. The warm saline Subtropical Underwater has high

alkalinity values, which are attributable to its high salinity. This water also has high TCO_2 values caused by the oxidation of biogenic debris in the water column. The CO_2 maximum is expressed especially strongly at about 200 - 300 meters at northern stations and is associated with a strong oxygen minimum (as low as 6 μmol/kg at Station 3379). The AAIW has low alkalinity, low TCO_2 and low AOU (i. e. high oxygen) values and is characterized by minima in the these quantities located at about 600 meters in water column. These features are more strongly expressed at the southwestern stations. Below this depth, alkalinity and TCO_2 changes smoothly by a small amount to the sea floor with. a broad, shallow maximum centered around 2000 - 3000 meters. This represents the North Pacific deep water returning southward from the North Pacific. This maximum is strongly expressed at Station 3331 located at the southwestern corner of the study area as the North Pacific Return water is undercut by the AABW which has lower alkalinity (2365 μeq/kg) and TCO_2 (2260 μmol/kg) values. The effects of AABW are clearly demonstrated in the alkalinity-salinity relationship. However, at the Chile Trench station, Station 3348, where measurements were made as deep as 5000 meters, the signals for AABW are weak in deep waters.

5) A non-linear relationship is observed between the alkalinity and TCO_2 in waters between about 600 meters (AAIW) and 3000 meters (North Pacific Return water). This suggests that both of these quantities are affected by the dissolution of $CaCO_3$ and/or by the oxidation of organic debris occurred in water column. Because only a few oxygen data are available for this depth range, the effect of $CaCO_3$ dissolution cannot be distinguished from that of the oxidation of organic debris.

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6. DATA TABLES

The following hydrographic and CO_2 chemistry data obtained at each station are listed in the following tables. The leg number, station number, positions, date of station occupation and the sea floor depth (m) are listed in each heading. The temperature, salinity and the concentrations of dissolved oxygen, phosphate, nitrate and silicate were measured by the staff of Prof. Gary Shaffer and Dr. Osvaldo Ulloa.

Bot No.	=	Niskin bottle number of each sample.
Press dbar	=	Pressure of sample in decibars.
Temp deg C	=	In situ temperature of water (°C).
Pot Temp deg C	=	Potential temperature of water (°C) computed for the sea surface.
Salinity o/oo	=	Measured salinity (PS scale).
Sigma Theta	=	Potential density (ppt) of seawater at sea surface.
Sigma 2000	=	Potential density (ppt) of seawater computed at 2000 db.
Sigma 4000	=	Potential density (ppt) of seawater computed at 4000 db.
Oxy, PO4, NO3, SiO3	=	Measured concentrations (µmol/kg) of oxygen, phosphate, nitrate and silicate dissolved in seawater.
AOU	=	Apparent oxygen utilization (µmol/kg) computed for the potential temperature.
TCO2 uM/kg	=	The total CO_2 concentration (µmol/kg) dissolved in seawater measured using a coulometer.

Final TCO2 µM/kg	=	TCO_2 (µmol/kg) in seawater samples measured immediately after the final measurement of pCO_2 at 20°C.
Final pCO2@20C uatm	=	pCO_2 (µatm) in seawater samples measured shortly before the final measurement of TCO_2.
Calc TALK Peng ueq/kg	=	Total alkalinity (µeq/kg) computed using the paired TCO_2 and pCO_2 data above with Peng et al. (1987) scheme.
Calc. TALK DOE	=	Titration alkalinity (µeq/kg) computed using the paired TCO_2 and pCO_2 data above with the DOE (1994) scheme.

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Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3321 Latitude 43-15.0S Longitude 75-15.0W Date 5/15/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final---- Calc. TALK			
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----	uM/kg	----	----	----	TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
117	1.2	11.942	11.942	33.341C	25.312	34.066	42.437			0.96		4.4					
116	5.0	11.939	11.938	33.351	25.321	34.075	42.446			0.96		4.4	2031.1	2032.5	532.7	2224.3	2218.4
115	14.7	11.939	11.937	33.340C	25.312	34.067	42.438			0.97		4.4					
114	25.0	11.899	11.896	33.335C	25.316	34.072	42.445			1.01		4.7	2033.5	2039.2	546.6	2227.1	2221.3
113	34.9	11.584	11.580	33.338C	25.377	34.146	42.531			1.26		7.4					
112	44.9	11.326	11.320	33.443C	25.506	34.284	42.677			1.48		9.4					
111	70.1	10.840	10.832	33.648C	25.753	34.548	42.957			1.65		10.7	2115.0	2111.8	824.7	2239.1	2233.6
110	94.5	9.475	9.464	34.114C	26.350	35.196	43.653			1.79		8.9	2153.8	2152.0	916.2	2268.6	2263.1
109	119.3	9.024	9.011	34.143C	26.445	35.311	43.786			1.71		7.6					
108	143.8	9.303	9.287	34.284C	26.512	35.363	43.826			2.16		14.9	2200.0	2189.8	1162.3	2274.8	2269.4
107	168.0	9.336	9.317	34.386C	26.587	35.435	43.895			2.49	28.3	21.0					
106	194.0	9.238	9.217	34.414C	26.625	35.477	43.941			2.51	28.1	21.2	2243.1	2230.8	1490.9	2284.1	2278.8
105	243.6	8.723	8.698	34.405	26.700	35.576	44.061			2.45	27.4	19.8	2236.1	2224.8	1425.4	2283.8	2278.6
104	293.8	8.268	8.237	34.386C	26.756	35.653	44.157			2.39	26.6	18.3	2227.8	2219.2	1363.2	2284.0	2278.8
103	344.6	7.736	7.701	34.361C	26.816	35.737	44.265			2.31	23.7	17.4					
102	395.1	6.912	6.876	34.318	26.899	35.858	44.422			2.14	30.9	15.3	2196.8	2191.0	1102.9	2284.0	2278.6
101	494.7	5.258	5.218	34.253C	27.058	36.099	44.739			1.83	25.5	14.9	2157.5	2159.6	859.8	2288.3	2282.4

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3323 Latitude 43-14.0S Longitude 76-00.0W Date 5/16/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----	uM/kg				TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
821	2.5	12.355	12.355	33.493C	25.352	34.088	42.441			0.66	4.6	1.2					
820	6.1	12.360	12.359	33.493C	25.351	34.086	42.440			0.67	4.9	1.4					
1022	10.7	12.239	12.238	33.457C	25.346	34.087	42.446			0.78	9.1	2.4					
818	12.6	12.357	12.355	33.493C	25.352	34.087	42.441			0.67	5.3	1.4	2010.8	2014.1	448.2	2238.0	2231.9
817	19.8	12.361	12.359	33.492C	25.350	34.086	42.440			0.66	5.1	1.5					
1021	21.9	12.302	12.299	33.446C	25.326	34.065	42.421			0.77	9.2	2.4					
815	30.0	12.360	12.356	33.492C	25.351	34.086	42.440			0.66	5.3	1.4					
1020	31.3	12.233	12.229	33.457C	25.348	34.089	42.448			0.78	9.3	2.4					
813	39.8	12.350	12.345	33.493C	25.353	34.089	42.444			0.68	6.0	1.6					
1018	41.5	12.204	12.199	33.552C	25.427	34.168	42.527			0.77	9.4	2.4					
812	50.4	12.229	12.222	33.486C	25.372	34.113	42.472			0.84	8.4	2.8					
1017	51.5	12.226	12.219	33.457C	25.350	34.091	42.451			0.78	9.8	2.5					
811	75.2	11.255	11.246	33.538C	25.594	34.373	42.768			1.45	17.4	8.2	2081.3	2081.4	686.8	2235.2	2229.4
1015	76.4	10.585	10.576	33.779C	25.900	34.704	43.121			1.65	21.8	9.3					
809	100.2	9.914	9.903	33.957C	26.154	34.984	43.426			1.79	21.3	9.7	2140.2	2138.2	875.8	2260.1	2254.5
1014	102.0	10.010	9.999	33.963C	26.143	34.969	43.407			1.27	17.0	6.3					
808	125.8	9.595	9.581	34.119C	26.334	35.175	43.628			1.93	23.3	10.8					
807	150.9	9.357	9.340	34.216C	26.450	35.300	43.761			2.06	21.5	11.9	2181.0	2176.1	1051.5	2274.5	2269.0
806	175.9	8.923	8.904	34.203C	26.509	35.379	43.858			2.00	27.1	10.8					
805	199.7	8.324	8.304	34.211C	26.609	35.505	44.009			1.88	25.2	8.8	2161.5	2158.9	936.6	2273.3	2267.7
804	251.1	7.559	7.534	34.313C	26.802	35.732	44.267			2.26	34.4	14.2	2206.1	2197.9	1171.4	2282.7	2277.2
803	301.6	6.779	6.752	34.299C	26.901	35.867	44.436			2.14	32.2	13.5	2191.6	2184.9	1074.6	2281.3	2275.7
802	351.9	6.217	6.187	34.278C	26.959	35.952	44.547			1.98	32.6	12.2					
801	401.9	5.851	5.817	34.261C	26.992	36.003	44.615			1.87	30.9	11.6	2161.7	2159.1	868.0	2286.1	2280.3
320	496.9	5.344	5.303	34.248C	27.044	36.080	44.716			1.82	27.8	14.8	2155.5	2156.2	833.6	2289.6	2283.7
319	602.2	4.908	4.860	34.243C	27.091	36.150	44.806			2.02	27.5	22.4	2174.7	2171.1	885.6	2296.7	2290.7
318	704.7	4.408	4.354	34.253C	27.155	36.239	44.920			2.19	28.1	34.3	2198.5	2195.3	996.7	2304.9	2298.9
317	804.6	3.971	3.912	34.302C	27.240	36.346	45.048			2.38	28.7	48.6	2223.9	2220.9	1097.1	2318.8	2312.7
316	904.2	3.512	3.448	34.358C	27.331	36.461	45.184			2.47	35.6	58.1	2243.2	2238.4	1168.7	2328.7	2322.6
315	1004.9	3.394	3.323	34.404C	27.379	36.515	45.243			2.57	36.6	68.0	2257.9	2251.3	1215.3	2337.3	2331.1
314	1106.8	3.246	3.168	34.442C	27.424	36.567	45.303			2.66	39.2	78.7	2271.7	2264.3	1243.5	2348.4	2342.1
313	1207.2	3.094	3.009	34.484C	27.473	36.624	45.366			2.70	35.1	95.7	2292.8	2285.3	1300.8	2364.9	2358.5
312	1412.4	2.816	2.718	34.546C	27.548	36.714	45.470			2.68	38.3	108.8	2302.3	2295.9	1251.2	2382.8	2376.2
311	1611.7	2.535	2.423	34.592C	27.610	36.791	45.562			2.65	37.9	117.3	2307.6	2300.0	1233.0	2389.8	2383.1
310	1816.2	2.323	2.197	34.620C	27.652	36.844	45.626			2.61	36.6	123.1	2308.2	2301.8	1201.1	2396.1	2389.3
309	2020.1	2.133	1.992	34.641C	27.685	36.888	45.680			2.58	37.9	128.2	2310.3	2302.3	1180.4	2399.5	2392.6
308	2223.0	2.002	1.846	34.656C	27.708	36.920	45.719			2.56	33.9	132.5	2311.2	2306.3	1162.9	2406.4	2399.5
307	2425.4	1.910	1.738	34.673	27.730	36.947	45.752			2.53	29.6	136.2	2312.7	2304.8	1133.4	2409.0	2402.0
306	2628.4	1.846	1.657	34.674C	27.737	36.958	45.767			2.53	29.1	136.9	2313.7	2307.6	1141.5	2410.9	2403.9
305	2833.2	1.810	1.602	34.679C	27.745	36.969	45.781			2.53	30.1	138.8	2315.3	2311.6	1132.7	2416.6	2409.6
304	3036.9	1.792	1.565	34.683	27.751	36.978	45.791			2.53	32.8	138.3	2314.0	2305.9	1130.7	2410.7	2403.6
303	3238.6	1.781	1.535	34.683C	27.753	36.981	45.797			2.51	29.5	139.0	2314.8	2310.1	1123.6	2416.3	2409.2
302	3439.5	1.766	1.500	34.685C	27.758	36.988	45.805			2.52	31.8	138.0	2312.6	2305.3	1111.3	2412.9	2405.8
301	3670.6	1.711	1.421	34.690	27.767	37.001	45.823			2.53	31.5	138.4	2317.3	2312.1	1129.2	2417.7	2410.7

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3325 Latitude 43-14.0S Longitude 78-00.0W Date 5/17/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	Sigma			Oxy	AOU	PO4	NO3	SiO3	TCO2	Final		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000			uM/kg				TCO2	pCO2@20C	Peng	DOE
120	5.0	13.074	13.073	33.860C	25.495	34.198	42.521			0.79	9.6	0.6					
118	10.1	13.089	13.088	33.861C	25.494	34.196	42.518			0.79	9.6	0.6	2034.5	2038.2	464.2	2261.2	2255.0
323	19.4	13.049	13.046	33.861C	25.502	34.205	42.529			0.79	32.8	0.6					
117	20.2	13.094	13.092	33.864C	25.495	34.197	42.519			0.78	9.5	0.6					
115	30.2	13.090	13.086	33.864C	25.496	34.199	42.521			0.80	9.5	0.6	2034.2	2040.6	467.5	2262.6	2256.4
321	49.6	12.955	12.948	33.848C	25.511	34.219	42.546										
112	50.4	12.958	12.951	33.867	25.525	34.232	42.560			0.79		0.5					
111	75.6	12.776	12.766	33.843C	25.544	34.258	42.593			0.80	9.4	0.5	2030.1	2039.2	467.8	2260.7	2254.5
110	100.8	10.712	10.700	33.887C	25.963	34.760	43.171			0.97	12.3	1.0	2054.2	2055.9	518.1	2259.6	2253.5
109	126.0	9.459	9.445	33.930C	26.209	35.058	43.519			1.17	14.6	1.6					
108	151.3	8.922	8.906	33.975C	26.331	35.204	43.686			1.29	19.0	2.3	2090.5	2089.5	619.8	2264.5	2258.5
107	176.5	8.481	8.462	34.047C	26.456	35.347	43.847			1.44	20.6	3.5					
106	201.7	8.185	8.165	34.122	26.560	35.463	43.974			1.57	22.5	4.9	2127.0	2126.0	767.6	2268.6	2262.9
105	252.2	7.455	7.431	34.209C	26.736	35.671	44.213			0.85	27.3	8.1	2159.3	2153.9	878.7	2275.9	2271.2
104	302.6	6.754	6.727	34.249	26.864	35.832	44.404			1.88	24.7	9.2	2164.6	2158.2	892.1	2280.5	2274.8
103	353.1	6.155	6.124	34.255C	26.948	35.945	44.543			1.73	23.4	8.6					
102	403.6	5.860	5.826	34.262C	26.992	36.003	44.614			1.71	25.3	9.0	2146.1	2143.1	790.3	2283.7	2277.9
320	501.7	5.234	5.193	34.255C	27.063	36.105	44.746										
101	504.6	5.455	5.413	34.255	27.037	36.068	44.699			1.74	17.0	10.3	2145.3	2142.3	785.5	2284.0	2278.0
319	603.2	5.187	5.138	34.245	27.061	36.106	44.749			1.78	34.7	11.5	2147.4	2146.3	787.7	2288.1	2282.1
318	703.2	4.861	4.805	34.241C	27.096	36.158	44.817			1.89	27.7	14.9	2157.1	2153.7	815.4	2290.7	2284.7
317	805.3	4.469	4.407	34.241C	27.140	36.222	44.900			2.04	32.6	21.1	2173.6	2168.8	886.0	2294.1	2288.0
316	907.4	3.985	3.918	34.294C	27.233	36.339	45.040			2.21	37.0	31.2	2169.1	2165.8	856.7	2297.2	2290.8
315	1007.0	3.608	3.535	34.341C	27.308	36.434	45.153			2.37	31.5	43.0	2216.9	2210.0	1048.3	2313.9	2307.8
314	1109.4	3.351	3.272	34.402C	27.382	36.521	45.252			2.51	28.9	55.1	2242.8	2234.2	1139.5	2328.1	2322.0
313	1210.1	3.160	3.074	34.445C	27.435	36.583	45.323			2.59	27.1	64.3	2257.8	2249.7	1198.3	2337.8	2331.6
312	1411.7	2.866	2.767	34.527C	27.528	36.691	45.446			2.69	32.1	82.9	2284.8	2275.7	1237.9	2361.9	2355.5
311	1613.8	2.615	2.502	34.576C	27.591	36.767	45.534			2.70	31.2	95.1	2295.7	2288.1	1266.7	2372.2	2365.8
310	1817.7	2.390	2.263	34.608C	27.636	36.825	45.604			2.66	31.6	104.7	2302.0	2293.8	1221.1	2384.4	2377.8
309	2019.5	2.193	2.052	34.631C	27.672	36.872	45.661			2.63	25.7	111.0	2306.8	2301.0	1207.1	2394.2	2387.5
308	2223.1	2.048	1.891	34.647C	27.697	36.906	45.703			2.59	26.5	115.7	2305.7	2299.2	1158.0	2398.9	2392.1
307	2425.6	1.946	1.773	34.659C	27.716	36.931	45.734			2.56	27.9	118.5	2307.8	2303.5	1147.9	2405.1	2398.2
306	2628.7	1.878	1.688	34.668C	27.730	36.950	45.757			2.55	30.3	122.0	2311.5	2304.3	1120.0	2410.1	2403.1
305	2833.7	1.836	1.628	34.673C	27.738	36.961	45.772			2.54	27.6	124.5	2311.4	2306.6	1137.3	2410.2	2403.2
304	3036.3	1.810	1.583	34.676	27.744	36.970	45.782			2.53	30.5	125.6	2313.2	2307.0	1122.5	2412.8	2405.8
303	3240.8	1.779	1.532	34.680	27.751	36.979	45.795			2.53	31.5	125.7	2311.4	2307.2	1129.5	2412.0	2405.0
302	3445.7	1.707	1.441	34.685	27.761	36.995	45.815			2.50	30.3	125.4	2308.6	2301.9	1103.9	2409.9	2402.9
301	3615.6	1.369	1.094	34.699	27.797	37.050	45.888			2.37	0.0	123.3	2284.9	2281.8	1052.9	2395.4	2388.4

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3327 Latitude 43-14.0S Longitude 80-00.0W Date 5/18/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot No.	Press dbar	Temp deg C	Pot Temp deg C	Salinity o/oo	Theta	Sigma 2000	Sigma 4000	Oxy	AOU	PO4 uM/kg	NO3 uM/kg	SiO3 uM/kg	TCO2 uM/kg	Final TCO2 uM/kg	Final pCO2@20C uatm	Calc. TALK Peng ----ueq/kg---	Calc. TALK DOE ----ueq/kg---
821	9.0	13.011	13.010	33.868	25.515	34.220	42.545			0.84	10.0	0.2					
418	10.2	12.975	12.973	33.857C	25.514	34.220	42.547			0.85	10.8	0.1	2036.7	2040.7	467.9	2262.5	2256.3
820	20.0	13.014	13.011	33.868	25.514	34.219	42.544			0.83	10.0	0.1					
417	20.4	12.978	12.975	33.859C	25.515	34.221	42.547			0.85	10.9	0.1					
819	29.1	13.015	13.011	33.867	25.514	34.218	42.544			0.84	6.0	0.1					
415	31.4	12.977	12.973	33.865	25.520	34.226	42.552			0.85	10.5	0.1	2036.9	2043.3	472.4	2263.6	2257.4
818	40.4	13.017	13.011	33.868	25.514	34.219	42.544			0.83	11.4	0.1					
414	41.1	12.960	12.955	33.858C	25.518	34.225	42.552			0.85	10.2	0.1					
816	50.0	13.016	13.009	33.871	25.517	34.222	42.547			0.85	6.5	0.2					
411	50.8	12.958	12.951	33.858C	25.518	34.226	42.553			0.85	10.2	0.1					
815	74.7	12.956	12.946	33.991	25.623	34.329	42.655			1.12	15.6	0.8					
410	75.0	12.956	12.946	33.858C	25.520	34.227	42.555			0.85	11.7	0.1	2036.5	2040.9	476.5	2259.0	2252.7
814	99.2	9.733	9.722	34.013	26.228	35.065	43.513			1.29	17.6	1.5					
409	100.3	10.389	10.378	33.886C	26.018	34.828	43.253			1.05	14.0	0.4	2059.4	2062.4	523.4	2265.3	2259.1
408	125.2	8.879	8.866	33.979C	26.340	35.215	43.698			1.27	17.6	1.4					
813	125.6	8.916	8.903	34.013	26.361	35.233	43.715			1.31	19.0	1.8					
812	149.7	8.299	8.284	34.012	26.456	35.356	43.863			1.32	18.1	1.8					
407	150.3	8.076	8.061	34.030C	26.503	35.413	43.929			1.36	17.9	2.0	2100.4	2098.6	641.8	2268.8	2262.8
406	176.2	7.521	7.504	34.092C	26.633	35.567	44.107			1.49	19.8	3.2					
405	201.9	7.341	7.322	34.186C	26.733	35.674	44.220			1.64	24.5	4.7	2136.8	2134.9	790.4	2274.0	2268.2
404	254.3	6.702	6.679	34.238C	26.862	35.833	44.406			1.78	24.0	6.7	2153.0	2148.2	830.5	2281.0	2275.2
403	304.6	6.219	6.192	34.256C	26.940	35.934	44.529			1.76	23.1	7.2	2150.8	2146.7	824.8	2280.5	2274.7
402	356.3	5.941	5.910	34.261C	26.980	35.987	44.595			1.69	23.9	7.0					
401	402.6	5.783	5.749	34.260C	27.000	36.014	44.630			1.68	21.7	7.4	2141.1	2138.6	761.0	2285.1	2279.2
320	502.2	5.389	5.348	34.252C	27.042	36.076	44.710			1.69	23.0	9.5	2142.9	2140.7	768.5	2285.8	2279.9
319	602.8	5.080	5.031	34.241C	27.070	36.120	44.769			1.76	24.4	11.4	2147.6	2145.6	792.7	2286.1	2280.2
318	704.3	4.696	4.641	34.243	27.115	36.185	44.852			1.89	21.8	16.0	2159.9	2156.3	817.8	2293.2	2287.1
317	805.3	4.208	4.148	34.258C	27.180	36.275	44.966			2.08	24.9	25.0	2181.7	2177.2	908.8	2299.4	2293.4
316	907.4	3.798	3.731	34.314C	27.268	36.384	45.093			2.27	33.2	36.8	2206.8	2200.8	1018.6	2307.9	2301.9
315	1007.4	3.469	3.397	34.373C	27.348	36.480	45.205			2.41	26.3	49.4	2231.4	2219.2	1107.2	2315.8	2309.7
314	1107.1	3.280	3.201	34.423C	27.406	36.548	45.282			2.52	31.9	60.3	2251.3	2243.7	1150.3	2337.3	2331.0
313	1209.3	3.171	3.085	34.456C	27.443	36.590	45.330			2.58	29.6	67.5	2263.6	2256.1	1217.3	2342.4	2336.2
312	1410.8	2.919	2.819	34.517C	27.516	36.676	45.428			2.65	33.5	80.8	2281.9	2274.3	1259.3	2357.6	2351.3
311	1614.8	2.613	2.500	34.574C	27.589	36.766	45.533			2.63	36.0	94.8	2295.3	2287.9	1234.3	2375.9	2369.4
310	1816.0	2.391	2.264	34.608C	27.636	36.825	45.604			2.61	33.0	104.3	2301.8	2291.8	1208.8	2383.7	2377.1
309	2019.7	2.189	2.048	34.633	27.674	36.875	45.664			2.57	30.1	141.0	2306.1	2299.2	1185.2	2395.7	2388.8
308	2219.6	2.043	1.887	34.643C	27.694	36.903	45.701			2.53		117.0	2306.1	2294.8	1109.9	2400.9	2394.0
307	2426.8	1.929	1.757	34.661C	27.719	36.935	45.739			2.52	30.6	120.3	2309.3	2302.7	1165.0	2401.8	2395.0
306	2629.9	1.874	1.684	34.668	27.730	36.950	45.758			2.50	32.0	123.0	2301.9	2296.6	1071.0	2409.0	2401.9
305	2833.4	1.836	1.628	34.673C	27.738	36.961	45.772			2.49	35.2	124.0	2311.8	2305.4	1140.9	2408.2	2401.4
304	3035.1	1.807	1.580	34.676C	27.744	36.970	45.783			2.49	33.3	125.4	2313.3	2307.2	1128.4	2412.0	2405.1
303	3240.8	1.739	1.493	34.682	27.756	36.986	45.804			2.46	33.8	125.4	2306.6	2300.8	1098.4	2409.4	2402.4
302	3445.8	1.607	1.344	34.690	27.773	37.011	45.837			2.41	32.6	124.7	2300.8	2296.2	1091.5	2405.3	2398.4
301	3501.3	1.592	1.323	34.689C	27.773	37.013	45.840			2.40	35.4	118.3	2300.7	2296.7	1087.2	2406.3	2399.5

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3329 Latitude 43-14.0S Longitude 82-00.0W Date 5/19/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----------	uM/kg				TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
123	9.6	12.605	12.604	33.832C	25.566	34.288	42.628			0.82	7.7	0.2					
314	10.5	12.616	12.615	33.818C	25.554	34.275	42.615			0.81	10.3	0.2	2036.4	2038.8	474.2	2257.2	2251.0
122	18.8	12.627	12.625	33.851C	25.578	34.298	42.637			0.84	10.5	0.2					
121	29.9	12.626	12.622	33.852C	25.579	34.299	42.638			0.84	8.2	0.2					
313	30.1	12.632	12.628	33.850C	25.576	34.296	42.635			0.81	10.1	0.2	2037.5	2041.8	473.8	2261.1	2254.9
120	40.3	12.629	12.623	33.853C	25.579	34.299	42.639			0.84	10.8	0.2					
118	49.2	12.629	12.623	33.855C	25.581	34.301	42.640			0.83	9.2	0.2					
312	50.5	12.626	12.619	33.852C	25.579	34.300	42.639			0.82	9.9	0.2					
311	76.1	12.588	12.578	33.853C	25.588	34.310	42.651			0.86	8.5	0.2	2038.0	2039.1	465.8	2261.6	2255.3
310	99.1	10.199	10.188	33.857C	26.028	34.847	43.279			1.05	11.7	0.5	2062.6	2061.5	531.1	2261.1	2255.0
309	124.9	8.782	8.769	33.951C	26.333	35.212	43.701			1.22	15.0	1.3					
308	150.7	7.963	7.948	34.027C	26.518	35.433	43.954			1.40	17.7	2.6	2107.4	2105.0	668.9	2268.5	2262.6
307	175.6	7.754	7.736	34.073C	26.585	35.508	44.038			1.47	16.5	3.4					
306	202.9	7.465	7.446	34.136C	26.676	35.612	44.154			1.63	19.2	5.2	2138.3	2135.2	793.0	2273.5	2267.8
305	253.6	6.573	6.551	34.226C	26.870	35.847	44.426			1.80	23.3	7.5	2157.5	2153.5	879.4	2277.4	2271.7
304	303.5	6.043	6.016	34.236C	26.947	35.949	44.552			1.66	18.4	7.0	2142.3	2140.6	792.9	2280.1	2274.3
303	355.3	6.175	6.144	34.262	26.951	35.947	44.544			1.64	16.0	7.7					
302	404.8	5.781	5.747	34.260	27.000	36.015	44.630			1.64	20.5	7.8	2141.1	2139.4	769.3	2284.1	2278.2
301	503.7	5.378	5.337	34.244C	27.036	36.072	44.706			1.70	17.9	8.9	2142.6	2140.1	774.1	2283.9	2278.0
117	605.5	5.095	5.046	34.241C	27.068	36.118	44.766			1.75	23.6	11.1	2147.8	2144.8	784.7	2286.9	2281.0
116	706.8	4.795	4.739	34.244	27.105	36.170	44.833			1.86	24.4	14.5	2157.4	2152.2	818.9	2288.2	2282.2
115	809.3	4.343	4.281	34.259C	27.167	36.255	44.939			2.04	26.6	21.8	2178.2	2173.4	912.5	2294.4	2288.4
114	909.9	3.930	3.862	34.290C	27.235	36.345	45.048			2.18	36.9	29.9	2195.1	2190.3	958.1	2305.7	2299.7
113	1010.5	3.535	3.463	34.341C	27.316	36.445	45.167			2.29	32.2	39.9	2214.7	2207.3	1035.3	2312.7	2306.7
112	1111.5	3.271	3.192	34.397C	27.386	36.529	45.264			2.41	30.1	50.2	2236.1	2228.9	1110.6	2326.0	2319.9
111	1213.8	3.079	2.994	34.462C	27.456	36.608	45.352			2.56	30.5	62.2	2259.4	2251.7	1192.2	2340.7	2334.5
110	1416.2	2.826	2.727	34.534C	27.538	36.703	45.459			2.63	34.5	77.9	2283.7	2276.5	1237.0	2362.7	2356.4
109	1617.8	2.605	2.492	34.577C	27.592	36.770	45.537			2.62	34.6	88.5	2296.3	2286.9	1229.1	2375.3	2368.9
108	1821.5	2.375	2.249	34.610C	27.639	36.829	45.608			2.58	35.3	96.6	2301.4	2293.8	1225.1	2383.5	2377.1
107	2026.7	2.187	2.045	34.632C	27.674	36.874	45.664			2.57	26.3	102.4	2304.7	2297.4	1207.0	2390.0	2383.4
106	2230.9	2.018	1.862	34.651C	27.703	36.913	45.712			2.51	30.4	108.0	2307.1	2302.3	1162.1	2401.4	2394.8
105	2432.1	1.931	1.758	34.661C	27.719	36.935	45.739			2.50	32.8	110.7	2307.8	2300.8	1158.3	2400.4	2393.7
104	2634.9	1.863	1.673	34.670C	27.732	36.953	45.761			2.48	31.8	112.7	2309.8	2304.5	1147.3	2406.0	2399.3
103	2840.9	1.823	1.614	34.674C	27.740	36.964	45.775			2.47	34.4	114.4	2308.4	2300.5	1124.1	2405.0	2398.2
102	3047.4	1.808	1.580	34.678	27.746	36.971	45.784			2.48	33.5	114.0	2308.9	2304.8	1138.6	2407.6	2400.9

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3331 Latitude 43-15.0S Longitude 86-00.0W Date 5/20/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----	uM/kg				TCO2	pCO2@20C	Peng	DOE
														uM/kg	uatm	----ueq/kg---	
320	8.5	12.359	12.358	33.874C	25.647	34.377	42.726			0.96	11.1	0.5	2049.6	2051.4	498.8	2262.0	2255.8
621	10.1	12.310	12.309	33.876C	25.658	34.390	42.741			0.34	12.6	0.0					
319	18.4	12.357	12.355	33.874C	25.648	34.378	42.727			0.98	11.1	0.4					
619	20.7	12.316	12.313	33.876C	25.657	34.389	42.740			0.36	12.6	0.0					
317	28.3	12.359	12.356	33.874C	25.647	34.377	42.726			0.97	11.3	0.4	2045.0	2047.1	493.2	2264.9	2258.4
617	30.2	12.277	12.273	33.878C	25.666	34.400	42.751			0.40	12.7	0.0					
316	38.9	12.361	12.356	33.873C	25.647	34.377	42.726			1.00	9.1	0.4					
615	39.9	12.251	12.245	33.880C	25.673	34.408	42.761			0.43	12.8	0.0					
313	49.6	12.359	12.352	33.874C	25.648	34.378	42.727			0.98	9.3	0.3					
613	50.8	12.200	12.194	33.884C	25.686	34.423	42.778			0.48	12.7	0.0					
310	73.8	11.795	11.786	33.883C	25.762	34.515	42.885			1.02	9.6	0.5	2051.7	2053.1	506.1	2261.2	2255.0
611	75.1	12.145	12.135	33.887C	25.700	34.439	42.796			0.51	12.7	0.0					
309	100.0	9.637	9.626	33.894C	26.151	34.994	43.448			1.11	8.1	1.1	2066.7	2067.7	553.4	2260.5	2254.4
609	101.5	9.636	9.624	33.913C	26.167	35.009	43.462			0.65	14.2	0.0					
308	124.1	9.009	8.996	33.949C	26.296	35.165	43.644			1.20	9.7	1.4					
607	125.4	8.683	8.670	33.975C	26.368	35.251	43.742			0.83	17.0	0.0					
307	150.8	8.115	8.100	34.041C	26.506	35.413	43.928			1.34	13.9	2.4	2096.7	2095.0	632.9	2267.3	2261.3
605	150.8	7.909	7.894	34.071C	26.560	35.477	44.000			1.00	18.9	0.0					
306	174.5	7.447	7.430	34.128C	26.672	35.609	44.151			1.53	14.7	4.3					
603	176.3	7.378	7.361	34.133C	26.686	35.626	44.171			1.14	21.0	0.3					
305	200.8	6.917	6.899	34.192C	26.797	35.757	44.322			1.64	20.1	6.0	2133.7	2129.7	757.1	2275.6	2269.8
601	202.4	7.056	7.037	34.183C	26.770	35.725	44.283			1.26	22.6	1.7					
304	250.2	6.251	6.229	34.237C	26.921	35.913	44.506			1.60	18.8	6.9	2130.6	2128.0	729.3	2280.4	2274.5
303	301.7	6.073	6.047	34.262C	26.964	35.964	44.566			1.60	19.3	7.7	2131.2	2128.0	718.5	2283.2	2277.2
302	353.2	5.883	5.853	34.273	26.996	36.006	44.616			1.61	17.7	8.4					
301	402.3	5.736	5.703	34.268	27.012	36.028	44.646			1.63	16.0	9.0	2132.5	2130.2	725.2	2284.2	2278.2
823	499.0	5.437	5.395	34.251C	27.035	36.068	44.699			0.81	15.3	1.3	2137.6	2134.8	739.8	2283.8	2278.7
822	601.5	5.099	5.050	34.256C	27.079	36.129	44.776			0.85	27.4	2.8	2146.2	2143.8	779.2	2284.9	2280.0
821	701.9	4.721	4.666	34.247	27.116	36.184	44.850			1.89	17.2	16.2	2160.8	2157.3	838.8	2290.0	2284.0
820	801.7	4.356	4.294	34.255C	27.162	36.250	44.933			2.05	18.4	22.6	2177.0	2172.4	898.6	2295.8	2289.8
819	901.9	4.016	3.949	34.295C	27.231	36.335	45.035			2.18	24.0	30.5	2194.7	2189.1	968.7	2302.7	2296.7
818	1002.7	3.610	3.538	34.339C	27.306	36.432	45.151			2.31	27.2	39.4	2212.6	2206.9	1037.1	2312.0	2306.0
817	1106.1	3.351	3.272	34.386C	27.369	36.508	45.239			2.41	26.7	48.7	2229.7	2222.8	1091.2	2322.0	2315.9
816	1206.1	3.193	3.107	34.440	27.428	36.574	45.313			2.52	28.9	59.5	2252.2	2244.6	1172.6	2335.3	2329.1
814	1410.0	2.834	2.736	34.520C	27.526	36.690	45.446			2.63	26.5	76.7	2295.3	2287.2	1249.2	2372.7	2366.4
813	1611.2	2.702	2.589	34.573C	27.581	36.753	45.516			2.64	26.5	90.0	2279.8	2272.8	1248.4	2357.6	2351.3
812	1813.3	2.434	2.307	34.605	27.631	36.817	45.594			2.60	32.3	97.5	2300.5	2293.1	1230.2	2382.1	2375.7
811	2016.8	2.229	2.088	34.624C	27.663	36.861	45.649			2.57	28.2	103.4	2301.8	2295.5	1189.4	2390.2	2383.6
810	2216.9	2.081	1.925	34.643C	27.692	36.899	45.694			2.53	30.4	107.3	2301.6	2295.1	1149.2	2395.4	2388.6
809	2423.8	1.986	1.813	34.657	27.712	36.925	45.726			2.50	30.3	110.0	2303.0	2298.8	1144.8	2400.1	2393.4
808	2626.2	1.893	1.703	34.665C	27.726	36.945	45.752			2.49	27.9	112.5	2304.5	2299.9	1139.7	2402.1	2395.3
807	2829.9	1.830	1.622	34.666C	27.733	36.957	45.768			2.48	27.4	114.9	2305.5	2297.5	1107.2	2404.2	2397.3
806	3035.5	1.779	1.553	34.678	27.748	36.975	45.790			2.44	28.5	115.9	2303.5	2298.8	1105.0	2405.9	2399.1
805	3236.6	1.727	1.482	34.679C	27.754	36.985	45.803			2.41	25.8	114.4	2297.5	2290.4	1085.8	2399.5	2392.7
804	3441.8	1.636	1.372	34.691	27.771	37.008	45.832			2.37	27.2	113.9	2291.9	2287.8	1076.1	2398.1	2391.3
803	3639.7	1.505	1.224	34.699C	27.788	37.034	45.865			2.33	22.6	113.5	2283.8	2278.0	1048.0	2391.7	2384.8
802	3850.6	1.480	1.178	34.701	27.793	37.041	45.874			2.32	29.3	113.6	2279.0	2276.8	1053.1	2389.5	2382.7
801	3867.6	1.481	1.177	34.703	27.795	37.043	45.877			2.31	29.9	113.9	2283.1	2278.3	1054.4	2391.0	2384.1

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3336 Latitude 35-30.0S Longitude 88-00.0W Date 5/23/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot No.	Press dbar	Temp deg C	Pot Temp deg C	Salinity o/oo	Sigma Theta	Sigma 2000	Sigma 4000	Oxy	AOU	PO4 uM/kg	NO3 uM/kg	SiO3 uM/kg	TCO2 uM/kg	Final TCO2 uM/kg	Final pCO2@20C uatm	Calc. TALK Peng ----ueq/kg---	Calc. TALK DOE ----ueq/kg---
123	10.0	17.781	17.779	34.210C	24.722	33.252	41.414			0.28	1.2	0.1					
122	155.7	11.796	11.776	33.964	25.827	34.579	42.948			0.89	11.6	0.9	2053.5	2053.6	511.3	2259.9	2253.8
121	180.7	11.066	11.044	34.023C	26.007	34.788	43.185			1.02	11.3	1.1					
120	306.4	7.938	7.907	34.247C	26.697	35.610	44.130			1.69	19.7	6.1					
119	355.9	7.093	7.060	34.289C	26.851	35.802	44.359			1.88	22.9	8.8					
118	407.5	6.516	6.479	34.304	26.941	35.920	44.501			1.89	19.7	8.9	2160.1	2154.9	861.3	2282.9	2277.1
117	507.4	5.943	5.899	34.287C	27.002	36.009	44.617			1.83	20.5	9.1	2150.5	2145.8	806.0	2283.7	2277.8
116	607.3	5.469	5.418	34.269	27.047	36.078	44.708			1.84	24.8	10.0	2147.1	2144.6	791.0	2285.6	2279.6
115	708.2	5.094	5.037	34.257	27.082	36.132	44.780			1.93	19.7	12.6					
114	1211.1	3.419	3.331	34.465C	27.427	36.561	45.288			2.80	38.1	62.8					
113	1413.8	3.118	3.016	34.536	27.513	36.663	45.404			2.85	37.9	77.8	2290.8	2278.4	1257.0	2362.7	2356.2
112	1616.9	2.758	2.643	34.574C	27.577	36.746	45.506			2.76	36.0	87.3					
111	1820.2	2.481	2.353	34.602	27.624	36.808	45.582			2.69	33.3	92.5	2294.0	2285.9	1173.9	2381.8	2375.1
110	2022.1	2.248	2.106	34.626C	27.664	36.861	45.647			2.64	31.2	98.1					
109	2217.8	2.024	1.868	34.646	27.698	36.908	45.707			2.50	27.4	98.3	2293.4	2286.1	1115.6	2390.2	2383.5
109	2217.8	2.024	1.868	34.646	27.698	36.908	45.707			2.56	28.1	100.9					
108	2428.4	1.942	1.769	34.663C	27.719	36.935	45.738			2.54	37.9	105.5					
107	2631.8	1.849	1.660	34.677	27.739	36.961	45.769			2.53	31.3	108.0	2299.0	2292.1	1099.5	2399.4	2392.5
106	2835.3	1.773	1.566	34.684C	27.751	36.978	45.791			2.51	32.2	110.0					
105	3037.8	1.679	1.455	34.694C	27.768	37.000	45.819			2.42	32.5	107.3	2294.7	2288.7	1077.2	2399.0	2392.1
105	3037.8	1.679	1.455	34.673	27.751	36.984	45.803			2.49	33.4	110.1					
104	3244.6	1.652	1.408	34.698C	27.774	37.009	45.831			2.41	23.4	107.5					
104	3244.6	1.652	1.408	34.698C	27.774	37.009	45.831			2.47	24.0	110.2					
103	3391.7	1.626	1.368	34.697	27.777	37.014	45.838			2.40	30.4	108.6	2295.2	2288.6	1064.7	2400.9	2393.9
103	3391.7	1.626	1.368	34.697	27.777	37.014	45.838			2.46	31.3	111.5					
102	3548.1	1.556	1.284	34.697	27.782	37.024	45.852			2.41	29.9	108.5					
102	3548.1	1.622	1.348	34.697	27.778	37.016	45.841			2.47	30.7	111.3					
101	3698.6	1.620	1.330	34.698C	27.780	37.019	45.845			2.40	29.4	109.3	2294.7	2289.9	1072.2	2401.2	2394.3
101	3698.6	1.620	1.330	34.698C	27.780	37.019	45.845			2.47	30.2	112.1					

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3340 Latitude 35-15.0S Longitude 82-00.0W Date 5/25/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----	uM/kg	----	----	----	TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
118	10.8	17.137	17.135	34.173	24.848	33.400	41.582			0.35	2.5	0.2	2011.0	2013.4	384.5	2274.6	2268.2
117	21.2	17.137	17.133	34.164C	24.842	33.394	41.577			0.34	2.6	0.2					
116	30.5	17.128	17.123	34.173	24.851	33.404	41.586			0.35	2.4	0.2	2011.3	2015.3	388.2	2274.7	2268.3
113	51.8	17.061	17.052	34.176	24.870	33.425	41.610			0.34	2.4	0.1					
112	76.7	15.470	15.458	34.042C	25.134	33.746	41.984			0.46	4.0	0.2	2017.9	2020.0	412.8	2265.7	2259.4
111	101.6	13.376	13.362	33.996C	25.543	34.233	42.544			0.59	4.5	0.4	2031.3	2034.2	450.7	2263.2	2257.0
108	126.4	12.610	12.593	33.989C	25.691	34.410	42.749			0.72	7.6	0.6					
107	150.7	11.712	11.693	33.962	25.841	34.596	42.969			0.91	11.3	0.8	2054.8	2054.3	514.5	2259.5	2253.4
106	174.5	11.161	11.140	34.024C	25.990	34.768	43.160			1.03	13.3	1.1					
105	201.0	10.235	10.212	34.115C	26.225	35.040	43.467			1.19	17.6	1.9	2092.1	2090.3	615.2	2267.3	2261.4
104	250.7	8.974	8.947	34.193C	26.495	35.362	43.840			1.46	19.2	4.0	2122.5	2118.9	719.0	2272.1	2266.3
103	300.9	7.978	7.948	34.304C	26.736	35.646	44.164			1.93	21.5	9.8	2172.7	2165.7	951.6	2278.7	2273.1
102	352.6	6.897	6.864	34.283C	26.873	35.834	44.399			1.82	28.1	8.6					
101	401.6	6.320	6.284	34.296	26.960	35.949	44.539			1.75	25.3	8.8	2150.2	2145.4	810.0	2282.3	2276.5
321	501.9	5.880	5.837	34.283C	27.007	36.017	44.628			1.65	24.4	7.8	2139.7	2140.3	773.7	2284.2	2278.4
320	602.6	5.473	5.423	34.265C	27.043	36.074	44.704			1.73	30.2	9.3	2148.3	2145.6	756.2	2294.3	2288.3
319	702.9	5.038	4.981	34.254	27.086	36.139	44.789			1.86	22.3	12.9	2153.2	2150.8	815.8	2287.3	2281.3
318	804.1	4.610	4.547	34.261C	27.141	36.215	44.886			2.03	31.4	19.7	2171.9	2167.6	880.9	2293.7	2287.7
317	904.3	4.152	4.083	34.315C	27.233	36.330	45.022			2.31	32.8	33.2	2206.3	2197.6	1011.0	2305.6	2299.5
316	1006.6	3.804	3.730	34.368C	27.311	36.426	45.135			2.47	34.9	45.4	2230.1	2223.2	1136.7	2316.1	2310.1
315	1106.4	3.586	3.505	34.427C	27.380	36.505	45.225			2.64	34.9	57.9	2255.3	2245.9	1234.0	2329.1	2322.9
314	1207.1	3.297	3.211	34.482C	27.452	36.592	45.325			2.71	39.1	70.9	2273.7	2263.6	1264.3	2345.2	2338.9
313	1410.7	3.001	2.901	34.552C	27.536	36.692	45.439			2.74	32.4	88.9	2300.5	2293.0	1275.1	2376.4	2370.0
312	1611.5	2.731	2.617	34.584C	27.587	36.757	45.518			2.70	34.9	97.7	2300.8	2293.9	1226.6	2383.6	2377.0
311	1814.8	2.435	2.308	34.610C	27.634	36.821	45.597			2.62	30.4	104.0	2299.3	2287.8	1151.2	2387.1	2380.3
310	2018.1	2.244	2.102	34.627	27.665	36.862	45.649			2.56	31.0	107.7	2299.1	2294.3	1157.5	2393.4	2386.6
309	2220.5	2.065	1.909	34.647C	27.696	36.904	45.700			2.50	37.2	111.0	2298.5	2289.0	1113.9	2393.8	2387.0
308	2423.6	1.954	1.782	34.660C	27.717	36.931	45.734			2.48	31.3	114.6	2299.0	2294.4	1106.0	2401.0	2394.1
307	2626.8	1.856	1.667	34.673	27.735	36.956	45.765			2.45	32.8	116.5	2299.8	2291.0	1103.2	2397.7	2390.8
306	2828.7	1.800	1.593	34.680C	27.746	36.971	45.784			2.44	33.9	119.1	2301.0	2291.4	1087.6	2400.5	2393.6
305	3033.7	1.745	1.519	34.686	27.757	36.985	45.801			2.44	28.3	121.1	2297.6	2288.6	1097.7	2396.0	2389.1
304	3238.6	1.699	1.454	34.689	27.764	36.997	45.816			2.41	29.7	120.8	2297.2	2290.4	1080.4	2400.5	2393.6
303	3443.2	1.613	1.350	34.693	27.774	37.013	45.837			2.41	28.6	122.6	2296.0	2289.0	1067.5	2401.1	2394.1
302	3749.0	1.569	1.275	34.696	27.782	37.025	45.853			2.39	25.9	122.9	2293.4	2287.6	1066.7	2399.6	2392.7
301	3974.0	1.555	1.237	34.697	27.786	37.030	45.861			2.38	31.2	123.7					

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3346 Latitude 35-15.0S Longitude 76-00.0W Date 5/28/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot No.	Press dbar	Temp deg C	Pot Temp deg C	Salinity o/oo	Sigma Theta	Sigma 2000	Sigma 4000	Oxy	AOU	PO4 uM/kg	NO3 uM/kg	SiO3 uM/kg	TCO2 uM/kg	Final TCO2 uM/kg	Final pCO2@20C uatm	Calc. TALK Peng ----ueq/kg---	Calc. TALK DOE ----ueq/kg---
319	10.1	16.579	16.578	34.167	24.975	33.546	41.746			0.37	1.5	0.2	2013.2	2018.8	385.7	2280.4	2274.0
318	19.9	16.579	16.576	34.160C	24.970	33.541	41.741			0.50	1.4	0.2					
317	30.5	16.536	16.531	34.151C	24.973	33.546	41.748			0.36	1.4	0.2	2013.7	2018.7	387.4	2279.2	2272.7
316	40.4	16.524	16.517	34.148C	24.975	33.548	41.750			0.84	1.8	0.3					
313	51.0	16.529	16.521	34.158	24.981	33.554	41.756			0.37	1.6	0.2					
311	75.7	16.532	16.520	34.161	24.983	33.557	41.758			0.38	1.8	0.2	2014.2	2020.3	390.5	2279.3	2272.9
309	100.7	13.358	13.344	33.984C	25.538	34.228	42.540			0.66	5.5	0.5	2036.8	2041.2	472.9	2261.2	2255.1
308	126.5	12.458	12.441	33.932C	25.676	34.402	42.747			0.82	9.1	0.7					
307	151.5	11.604	11.585	33.971C	25.868	34.628	43.004			1.01	8.4	1.1	2065.5	2065.4	541.6	2262.3	2256.2
306	177.1	10.765	10.744	34.052C	26.084	34.877	43.284			1.17	15.4	1.7					
305	201.6	10.263	10.240	34.142C	26.241	35.054	43.480			1.52	17.3	4.1	2123.1	2118.4	737.8	2266.9	2261.1
304	252.3	9.631	9.602	34.324C	26.491	35.328	43.777			2.13	20.4	11.3	2191.0	2182.9	1089.9	2276.9	2271.5
303	302.8	9.008	8.975	34.425C	26.672	35.535	44.008			2.46	30.7	15.7	2229.9	2216.7	1360.4	2281.8	2276.5
302	351.8	7.958	7.922	34.391C	26.807	35.718	44.235			2.39	24.8	15.0					
301	404.3	7.419	7.380	34.406C	26.898	35.833	44.373			2.55	27.6	17.7	2231.4	2221.6	1364.1	2286.9	2281.5
122	504.8	5.971	5.927	34.295C	27.005	36.010	44.617			1.94	25.9	10.6	2309.6	2303.4	1132.1	2402.1	2396.8
121	605.4	5.372	5.322	34.257C	27.049	36.084	44.719			1.76	22.3	9.1	2310.9	2303.0	1129.7	2401.4	2396.3
120	706.3	4.916	4.860	34.252	27.098	36.157	44.813			1.91	26.4	13.4	2311.8	2306.7	1130.1	2405.8	2400.5
119	807.7	4.408	4.346	34.287C	27.183	36.267	44.947			2.23	26.0	24.4	2306.9	2297.3	1084.4	2403.2	2397.4
118	909.3	4.088	4.019	34.366C	27.280	36.380	45.075			2.57	39.2	39.9	2302.6	2296.3	1091.1	2402.5	2396.2
117	1010.2	3.721	3.647	34.419C	27.360	36.478	45.191			2.69	35.5	52.0	2297.4	2291.5	1080.8	2399.5	2393.0
116	1111.2	3.522	3.442	34.461C	27.413	36.542	45.264			2.76	44.2	61.1	2295.6	2291.0	1079.5	2399.7	2393.0
115	1212.8	3.316	3.229	34.496C	27.461	36.600	45.332			2.79	38.2	69.5	2167.7	2163.9	913.1	2287.6	2280.4
114	1416.2	2.974	2.873	34.551C	27.538	36.695	45.444			2.79	36.6	82.3	2144.7	2143.6	788.3	2290.6	2282.7
113	1612.4	2.651	2.538	34.589C	27.598	36.773	45.538			2.75	38.4	92.1	2159.3	2153.8	826.8	2294.1	2286.3
112	1814.5	2.398	2.272	34.615C	27.642	36.830	45.608				28.0		2191.1	2186.2	980.6	2301.7	2294.5
111	2017.4	2.210	2.068	34.635C	27.674	36.873	45.661				28.0		2233.0	2224.7	1178.1	2314.8	2308.2
110	2220.3	2.057	1.901	34.650	27.699	36.907	45.704				32.5		2255.4	2246.5	1256.6	2328.7	2322.3
109	2423.3	1.948	1.775	34.661C	27.718	36.933	45.736				34.6		2270.3	2260.2	1289.2	2339.6	2333.3
108	2626.8	1.873	1.683	34.669C	27.731	36.951	45.759				27.3		2284.6	2274.2	1325.8	2350.6	2344.3
107	2830.3	1.831	1.623	34.674	27.740	36.963	45.774				24.1		2298.0	2289.5	1337.8	2365.7	2359.5
106	3034.3	1.796	1.569	34.680C	27.748	36.974	45.788				34.2		2306.1	2299.7	1307.5	2380.3	2374.0
105	3238.7	1.773	1.526	34.684C	27.754	36.983	45.799				35.7		2308.3	2301.1	1251.6	2388.6	2382.1
104	3442.9	1.745	1.478	34.685C	27.759	36.990	45.808				27.2		2310.2	2302.8	1252.5	2390.4	2383.9
103	3730.4	1.674	1.379	34.692	27.772	37.008	45.832				27.6		2311.1	2305.1	1206.6	2398.8	2392.2
102	4053.0	1.586	1.259	34.696	27.783	37.026	45.856				30.6		2310.4	2305.6	1179.8	2403.0	2396.3
101	4326.7	1.599	1.241	34.696	27.785	37.029	45.860				28.0		2308.3	2299.0	1124.7	2403.5	2396.6

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3348 Latitude 35-15.0S Longitude 74-00.0W Date 5/28/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot No.	Press dbar	Temp deg C	Pot Temp deg C	Salinity o/oo	Sigma Theta	Sigma 2000	Sigma 4000	Oxy	AOU	PO4 uM/kg	NO3 uM/kg	SiO3 uM/kg	TCO2 uM/kg	-----Final---- TCO2 uM/kg	pCO2@20C uatm	Calc. TALK Peng ----ueq/kg---	DOE
115	9.3	15.526	15.524	33.942	25.042	33.653	41.890			0.29	0.1	0.0	1974.9	1983.8	343.1	2264.3	2257.7
114	19.2	14.638	14.635	33.852C	25.167	33.811	42.079			0.44	1.1	0.2					
113	30.0	13.972	13.967	33.917C	25.357	34.025	42.316			0.56	1.8	0.3	2013.3	2021.7	405.2	2271.4	2265.0
112	40.9	13.623	13.617	33.995	25.490	34.170	42.472			0.78	2.9	0.8					
111	51.0	12.884	12.877	33.942C	25.598	34.307	42.636			0.94	8.6	0.9	2052.4	2055.6	503.5	2265.4	2259.2
110	75.5	11.752	11.742	33.897C	25.781	34.536	42.907			0.93	8.2	0.6					
109	101.1	11.181	11.168	33.922C	25.906	34.684	43.077			1.08	11.4	1.2					
108	125.7	10.829	10.814	34.140C	26.140	34.928	43.332			1.70	23.2	5.7					
107	151.4	9.960	9.943	34.200C	26.337	35.162	43.599			1.90	21.1	8.3	2165.8	2157.8	943.7	2270.8	2265.3
106	176.4	9.499	9.479	34.299C	26.492	35.335	43.789			2.04	22.3	10.4					
105	201.8	9.737	9.714	34.518C	26.625	35.454	43.896			2.67	24.6	20.3	2255.3	2236.7	1550.3	2285.4	2280.1
104	252.2	8.492	8.466	34.392C	26.726	35.612	44.106			2.39	22.5	15.4	2223.1	2211.6	1318.4	2280.6	2275.3
103	302.4	7.648	7.618	34.366C	26.832	35.757	44.287			2.36	31.2	15.0	2216.0	2205.9	1259.4	2281.0	2275.6
102	353.2	7.133	7.100	34.378C	26.916	35.864	44.417			2.44	38.1	17.3					
101	404.7	6.499	6.462	34.329C	26.963	35.942	44.524			2.20	22.5	14.5	2195.7	2187.8	1095.3	2281.7	2276.2
314	503.8	5.600	5.557	34.283C	27.041	36.065	44.689			1.96	20.3	12.4	2165.5	2162.3	901.2	2283.8	2278.0
313	605.4	5.055	5.007	34.268	27.094	36.145	44.795			2.02	20.6	15.8	2169.4	2168.7	916.2	2288.4	2282.5
312	706.9	4.622	4.566	34.290C	27.161	36.234	44.904			2.22	17.9	24.5	2191.5	2186.0	996.5	2294.7	2288.7
311	807.4	4.167	4.106	34.344C	27.253	36.349	45.040			2.46	23.1	38.9	2223.2	2213.4	1100.4	2310.2	2304.1
310	908.5	3.798	3.732	34.387C	27.326	36.440	45.149			2.57	28.9	48.6	2241.4	2234.4	1196.3	2320.8	2314.8
309	1010.2	3.543	3.471	34.444C	27.397	36.524	45.244			2.69	21.1	61.1	2265.9	2256.4	1272.7	2336.0	2329.9
308	1111.2	3.449	3.369	34.498C	27.450	36.582	45.306			2.81	30.9	73.4	2284.9	2271.9	1321.1	2347.8	2341.6
307	1212.7	3.220	3.133	34.526C	27.494	36.638	45.374			2.79	36.7	80.4	2295.4	2287.4	1351.8	2361.3	2355.0
306	1414.6	2.876	2.777	34.568C	27.560	36.722	45.475			2.77	31.7	90.7	2303.4	2295.6	1328.7	2373.0	2366.7
305	1618.1	2.604	2.491	34.596C	27.608	36.785	45.552			2.73	31.4	99.3	2311.3	2301.8	1288.4	2384.7	2378.2
304	1821.3	2.389	2.262	34.618C	27.644	36.833	45.612			2.68	27.6	104.5	2311.9	2298.7	1219.1	2390.0	2383.4
303	2024.0	2.207	2.065	34.635C	27.674	36.874	45.662			2.64	31.6	108.8	2313.0	2301.1	1189.0	2396.7	2389.9
302	2227.8	2.064	1.907	34.648	27.697	36.905	45.701			2.61	32.0	112.9	2313.0	2304.3	1191.1	2400.0	2393.2
301	2432.2	1.966	1.792	34.659C	27.715	36.929	45.731			2.57	31.1	113.1	2310.6	2301.8	1151.6	2402.6	2395.8
315	2633.7	1.897	1.707	34.667C	27.728	36.946	45.753				21.6	114.3	2311.1	2303.0	1135.6	2406.8	2399.6
323	2839.6	1.850	1.641	34.672C	27.736	36.959	45.769			2.52	19.2	115.9	2311.9	2304.7	1128.6	2409.1	2402.2
322	3044.1	1.817	1.589	34.676C	27.744	36.969	45.782			2.52	35.1	117.5					
321	3248.5	1.799	1.551	34.679C	27.749	36.976	45.791			2.50	35.6	117.6	2312.3	2306.1	1120.4	2411.8	2405.0
320	3451.9	1.785	1.517	34.682C	27.754	36.983	45.799			2.48	20.8	117.0	2312.4	2301.8	1078.4	2413.4	2406.4
319	3759.7	1.750	1.450	34.687C	27.762	36.995	45.815			2.45	23.7	114.4	2307.8	2298.5	1084.4	2408.7	2401.8
318	4067.2	1.726	1.393	34.688C	27.767	37.003	45.826			2.45	34.4	113.6	2305.8	2298.7	1073.8	2410.6	2403.6
317	4580.0	1.725	1.334	34.691	27.774	37.013	45.839			2.44	30.7	115.1	2304.2	2298.7	1089.9	2408.1	2401.2
316	5082.3	1.730	1.278	34.694	27.781	37.023	45.852			2.26	24.7	114.6	2300.6	2293.3	1068.8	2405.1	2398.3

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3361 Latitude 35-15.0S Longitude 72-45.0W Date 5/31/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----------	uM/kg	----------	----------	----------	TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
117	10.3	13.390	13.389	34.234	25.722	34.407	42.714			2.90	22.6	26.1	2065.4	2069.3	497.9	2290.7	2281.9
116	20.7	12.677	12.674	34.231C	25.862	34.575	42.908			1.61	8.5	4.7					
115	30.3	12.495	12.491	34.240C	25.905	34.625	42.964			1.56	11.8	3.8	2120.0	2123.0	702.8	2281.2	2275.3
114	40.3	12.058	12.052	34.291C	26.029	34.765	43.120			1.91	17.0	8.1					
113	51.0	11.749	11.743	34.321C	26.111	34.860	43.225			2.23	19.2	12.4	2184.6	2174.8	1044.9	2274.8	2269.1
112	75.4	11.430	11.421	34.482C	26.296	35.055	43.431			2.60	21.2	18.2	2232.7	2220.2	1392.7	2282.7	2277.3
111	101.6	11.419	11.407	34.624C	26.409	35.167	43.541			2.82	21.9	24.1	2259.2	2244.8	1591.2	2291.0	2285.6
110	126.2	11.286	11.271	34.656	26.459	35.222	43.601			2.88	14.2	26.3					
109	150.8	10.968	10.949	34.633C	26.499	35.276	43.667			2.90	19.0	24.7	2266.4	2250.0	1639.4	2292.6	2287.1
108	176.6	10.713	10.692	34.608C	26.526	35.313	43.715			2.82	13.2	24.3					
107	200.8	10.605	10.581	34.629	26.561	35.353	43.759			2.84	26.9	24.8	2266.4	2250.3	1652.2	2291.7	2286.3
106	252.1	10.189	10.160	34.599C	26.612	35.422	43.845			2.82	15.7	24.7	2266.3	2248.5	1610.4	2293.2	2287.8
105	302.7	9.346	9.313	34.554C	26.719	35.565	44.023			2.85	25.5	25.1	2265.3	2252.8	1695.9	2290.5	2285.1
104	352.1	8.476	8.439	34.496C	26.812	35.698	44.192			2.78	19.9	24.3					
103	403.2	7.610	7.570	34.439C	26.896	35.822	44.354			2.68	22.2	23.5	2241.2	2232.9	1480.7	2287.7	2282.3
101	420.1	7.298	7.257	34.418C	26.925	35.865	44.411			2.65	18.1	23.1	2238.9	2228.9	1422.2	2289.1	2283.6

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3364 Latitude 35-15.0S Longitude 73-15.0W Date 6/ 1/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	Sigma			Oxy	AOU	PO4	NO3	SiO3	TCO2	Final TCO2	Final pCO2@20C	Calc. TALK Peng	Calc. TALK DOE
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	uM/kg						uM/kg	uatm	ueq/kg	ueq/kg
123	9.8	13.337	13.336	34.164C	25.678	34.366	42.676			0.84	3.5	0.0	2045.2	2051.1	464.1	2278.3	2271.9
122	29.1	12.948	12.944	34.187C	25.774	34.478	42.801			1.48	9.5	2.5	2114.0	2113.7	681.6	2275.8	2269.9
121	50.2	11.268	11.261	34.274C	26.163	34.932	43.316			2.12	21.0	9.1	2187.1	2178.9	1093.4	2271.8	2266.4
120	76.2	11.143	11.134	34.388C	26.275	35.047	43.435			2.25	17.6	12.8	2205.1	2199.2	1218.9	2278.4	2273.0
119	101.7	11.340	11.327	34.583C	26.392	35.153	43.531			2.58	18.9	19.4	2241.9	2230.3	1448.6	2288.2	2282.8
118	125.7	11.214	11.198	34.640C	26.460	35.226	43.608			2.71	21.5	22.7					
117	152.4	10.659	10.641	34.565C	26.501	35.291	43.696			2.61	19.9	20.4	2254.5	2238.7	1536.0	2288.9	2283.6
116	175.8	10.508	10.487	34.598C	26.554	35.350	43.760			2.68	17.6	22.2					
115	201.7	10.252	10.228	34.596	26.598	35.405	43.825			2.68	24.6	22.1	2263.9	2248.4	1647.2	2289.6	2284.4
114	252.7	9.564	9.535	34.567C	26.692	35.529	43.977			2.68	25.0	22.8	2267.1	2252.8	1666.3	2292.6	2287.4
113	303.1	8.933	8.900	34.536C	26.771	35.636	44.110			2.68	26.2	23.1	2262.9	2249.8	1665.5	2289.4	2284.2
112	405.5	7.465	7.426	34.438C	26.916	35.849	44.387			2.53	31.5	21.2	2241.1	2232.0	1447.5	2289.7	2284.3
111	505.6	6.166	6.121	34.343C	27.018	36.014	44.611			2.17	23.4	17.1	2197.2	2193.4	1120.8	2284.4	2278.9
110	605.0	5.421	5.370	34.302	27.078	36.111	44.743			2.06	25.4	17.7	2183.6	2182.6	998.0	2290.2	2284.5
109	706.1	4.981	4.924	34.317C	27.143	36.197	44.850			2.21	21.4	25.4	2203.3	2196.6	1061.2	2296.5	2290.7
108	808.6	4.587	4.523	34.365C	27.225	36.299	44.970			2.43	24.4	37.9	2233.0	2222.9	1182.7	2309.5	2303.6
107	909.7	4.234	4.164	34.415C	27.303	36.395	45.082			2.61	24.6	51.0	2257.7	2249.1	1298.4	2324.6	2318.7
106	1010.8	3.947	3.870	34.447	27.360	36.466	45.167			2.66	33.3	60.6	2271.3	2259.7	1317.1	2334.3	2328.4
105	1111.7	3.624	3.542	34.470C	27.411	36.534	45.251			2.64	22.7	67.8	2278.8	2264.6	1312.3	2340.4	2334.3
104	1212.1	3.410	3.322	34.508C	27.462	36.596	45.323			2.69	28.7	77.5	2291.8	2280.1	1339.3	2354.5	2348.3
103	1415.7	3.050	2.949	34.553C	27.533	36.686	45.431			2.65	31.9	90.9	2302.8	2293.1	1351.0	2367.5	2361.3
102	1617.9	2.701	2.587	34.587	27.592	36.764	45.527			2.58	26.7	101.6	2310.4	2302.9	1321.6	2381.6	2375.4
101	1822.4	2.431	2.303	34.614	27.638	36.825	45.601			2.60	25.9	108.9	2312.6	2303.4	1276.6	2387.8	2381.4

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3379 Latitude 28-15.0S Longitude 71-30.0W Date 6/ 9/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------		Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------		uM/kg			TCO2	pCO2@20C	Peng	DOE
													uM/kg	uatm	----ueq/kg---	
108	9.5	14.844	14.843	34.416	25.557	34.186	42.440			0.88	7.1	0.4	2078.2	2079.0	516.8	2289.6	2283.5
107	19.2	14.832	14.829	34.419C	25.562	34.191	42.446			1.59	18.5	3.8					
106	29.9	14.611	14.606	34.396C	25.592	34.230	42.493			0.98	8.8	0.6	2088.4	2093.9	566.1	2288.5	2282.5
104	49.9	12.209	12.202	34.287	25.997	34.728	43.077			1.67	19.1	4.8	2152.9	2152.5	883.1	2275.5	2270.0
103	75.8	12.240	12.230	34.539C	26.187	34.913	43.258			2.36	21.0	14.7	2228.3	2221.6	1311.3	2292.6	2287.2
223	91.2	12.657	12.645	34.697C	26.229	34.937	43.265	25	236	2.57	18.8	19.8					
101	100.5	12.502	12.488	34.728	26.284	34.997	43.330			2.62	17.8	23.6	2255.4	2246.8	1469.1	2304.4	2299.0
222	126.7	12.403	12.386	34.762C	26.330	35.047	43.383	15	246	2.67	18.1	24.1					
221	151.7	12.048	12.028	34.743	26.385	35.116	43.466			2.66	20.5	23.7	2270.6	2256.0	1575.9	2304.3	2299.0
220	176.8	11.662	11.640	34.726C	26.445	35.192	43.556	11	255	2.67	22.9	23.8					
219	185.7	11.536	11.512	34.729C	26.471	35.223	43.592	13	254	2.67	23.6	24.3					
218	200.9	11.365	11.340	34.728	26.502	35.261	43.637	11	257	2.67	24.9	24.7	2278.2	2266.7	1664.1	2308.0	2302.8
217	251.8	10.560	10.530	34.694C	26.622	35.414	43.822	11	261	2.72	29.1	26.2	2275.2	2260.9	1688.3	2299.8	2294.6
216	303.2	10.176	10.140	34.672C	26.672	35.482	43.905	9	266	2.75	31.9	27.0	2277.6	2265.2	1719.0	2301.9	2296.7
215	353.4	9.410	9.370	34.616C	26.758	35.601	44.055	13	267	2.78	35.1	27.3					
214	403.3	8.444	8.402	34.548C	26.859	35.745	44.240	28	258	2.75	33.7	27.3	2272.1	2261.3	1709.5	2298.2	2293.0
213	505.2	7.060	7.012	34.474	27.003	35.954	44.510	65	230	2.69	38.4	28.5	2255.7	2245.3	1506.4	2298.8	2293.3
212	605.0	5.994	5.941	34.399	27.085	36.088	44.693	113	190	2.21	44.2	28.2	2235.0	2227.0	1318.5	2297.1	2291.9
211	706.6	5.397	5.338	34.395C	27.156	36.189	44.821	111	196	2.60	44.8	36.1	2243.0	2236.3	1341.1	2305.6	2300.0
210	807.4	4.811	4.746	34.407C	27.234	36.296	44.956	109	203	2.69	51.4	46.1	2257.4	2249.9	1380.2	2316.5	2310.7
209	908.8	4.426	4.355	34.451C	27.312	36.393	45.071	93	221	2.81	52.0	60.2	2278.5	2268.3	1437.4	2331.0	2325.1
208	1009.6	4.062	3.985	34.481	27.375	36.474	45.169	95	222	2.81	44.7	70.4	2289.4	2279.4	1447.1	2342.2	2336.2
207	1110.9	3.816	3.732	34.497	27.413	36.526	45.233	96	223	2.81	47.4	77.5	2294.4	2284.9	1439.5	2349.1	2343.0
206	1212.1	3.566	3.477	34.518C	27.455	36.581	45.300	100	221	2.80	37.3	84.9	2300.0	2291.6	1417.6	2358.8	2352.6
205	1415.0	3.085	2.983	34.555C	27.532	36.683	45.426	109	216	2.74	38.8	97.4	2306.8	2297.8	1363.0	2371.6	2365.3
204	1617.7	2.715	2.601	34.589	27.592	36.763	45.525	117	211	2.68	39.2	108.2	2313.2	2301.0	1288.1	2383.9	2377.4
203	1820.2	2.396	2.269	34.587	27.619	36.808	45.587	116	215	2.68	39.1	108.5	2312.4	2306.3	1338.8	2383.7	2377.3
202	2023.7	2.159	2.018	34.638	27.681	36.883	45.673	137	196	2.55	26.4	123.4					
201	2079.0	2.106	1.961	34.642	27.688	36.893	45.687	139	195	2.50	37.5	124.7	2315.7	2305.8	1192.1	2401.5	2394.8

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3382 Latitude 28-15.0S Longitude 72-30.0W Date 6/ 9/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----------	uM/kg	----------			TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
322	9.9	15.622	15.621	34.375C	25.354	33.955	42.184	248	-2	0.62	3.0	0.0	2045.1	2047.3	427.4	2292.7	2286.2
320	19.9	15.610	15.607	34.376C	25.357	33.959	42.188			0.63	3.1	0.0					
318	29.9	15.593	15.588	34.378C	25.363	33.966	42.195	247	-1	0.63	3.0	0.0	2045.9	2053.9	447.2	2290.4	2284.1
316	40.1	15.435	15.428	34.346C	25.374	33.983	42.218			0.66	3.8	0.0					
314	50.1	15.169	15.161	34.310	25.406	34.025	42.269	243	5	0.73	4.8	0.1					
313	59.6	13.117	13.109	34.083C	25.661	34.359	42.678			0.94	10.1	0.5					
312	74.8	12.202	12.193	34.085C	25.842	34.576	42.928	208	56	1.21	14.2	1.9	2094.7	2094.3	633.2	2266.3	2260.5
311	79.5	11.992	11.982	34.114C	25.905	34.647	43.007			1.37	16.0	3.2					
310	90.0	11.803	11.792	34.220C	26.023	34.771	43.136	.		1.70	18.7	6.4					
308	100.6	11.638	11.626	34.327	26.137	34.890	43.260	130	137	1.95	20.3	9.7	2175.6	2174.5	1020.1	2277.5	2272.1
307	125.0	11.289	11.273	34.451C	26.299	35.064	43.446			2.39	22.4	17.5					
306	150.4	11.348	11.329	34.643C	26.438	35.199	43.576	18	250	2.69	23.7	24.0	2261.3	2245.8	1540.6	2296.5	2291.1
305	174.8	11.277	11.256	34.711C	26.504	35.267	43.646	7	261	2.74	24.5	26.5					
304	200.4	10.707	10.682	34.663	26.570	35.357	43.759	10	261	2.73	27.0	26.0	2269.1	2258.3	1680.3	2297.7	2292.4
303	251.0	9.802	9.773	34.611C	26.687	35.513	43.951	16	261	2.73	31.5	26.3	2269.7	2255.5	1651.0	2297.1	2291.8
302	301.2	9.324	9.291	34.620C	26.774	35.620	44.078	11	269	2.84	34.2	29.5	2278.0	2264.7	1733.0	2300.3	2295.0
301	352.9	8.616	8.578	34.566	26.845	35.724	44.211	20	265	2.83	36.0	29.2					
123	403.2	8.082	8.041	34.535	26.903	35.806	44.316	32	256	2.76	38.0	28.2	2270.1	2257.7	1665.2	2298.1	2292.8
122	504.6	6.863	6.816	34.456C	27.016	35.976	44.541	78	218	2.64	37.5	27.9	2248.7	2241.3	1471.0	2297.7	2292.3
121	605.2	6.048	5.994	34.418C	27.093	36.094	44.695	97	205	2.61	31.7	31.4	2244.8	2234.9	1368.9	2301.1	2295.5
120	706.3	5.381	5.322	34.409	27.169	36.203	44.835	99	208	2.68	39.4	38.2	2251.5	2243.4	1391.6	2308.1	2302.5
119	807.8	4.853	4.788	34.441C	27.256	36.316	44.973	88	223	2.81	40.4	50.8	2271.9	2260.1	1438.5	2321.9	2316.0
118	907.7	4.380	4.309	34.452C	27.318	36.401	45.081	94	221	2.80	39.7	58.8	2276.7	2265.5	1407.8	2331.0	2325.0
117	1009.1	4.065	3.988	34.484	27.377	36.477	45.172	90	227	2.83	41.0	69.4	2291.2	2280.5	1454.6	2342.7	2336.7
116	1110.2	3.775	3.692	34.501C	27.420	36.535	45.244	97	223	2.81	40.5	75.2	2294.1	2281.4	1396.7	2349.8	2343.6
115	1212.3	3.543	3.453	34.519C	27.459	36.586	45.306	100	221	2.79	34.8	81.6	2299.1	2289.0	1401.4	2357.6	2351.4
114	1414.9	3.077	2.976	34.559	27.535	36.687	45.430	108	217	2.75	39.0	94.8	2308.3	2299.8	1368.6	2373.1	2366.8
113	1617.8	2.721	2.606	34.588C	27.591	36.762	45.524	118	210	2.70	36.4	104.2	2313.2	2303.9	1323.2	2382.9	2376.4
112	1819.5	2.438	2.310	34.615C	27.638	36.824	45.601	124	206	2.64	38.1	112.1	2316.2	2309.2	1274.5	2394.5	2388.0
111	2023.2	2.237	2.095	34.632C	27.669	36.867	45.654	130	202	2.59	35.1	117.3	2316.7	2307.6	1231.3	2398.3	2391.6
110	2227.0	2.082	1.925	34.646C	27.694	36.901	45.697	138	195	2.54	35.6	120.7	2316.4	2309.6	1198.9	2404.7	2398.0
109	2430.2	1.970	1.797	34.655	27.711	36.925	45.727	144	191	2.49	36.1	121.8	2314.8	2307.6	1178.2	2405.3	2398.6
108	2634.5	1.888	1.698	34.666	27.727	36.946	45.753	147	188	2.47	35.7	124.4	2313.5	2308.2	1152.3	2409.6	2402.8
107	2837.0	1.831	1.623	34.671C	27.737	36.961	45.772	149	187	2.45	35.4	126.3	2316.1	2308.7	1139.9	2411.9	2405.1
106	3042.0	1.805	1.578	34.674	27.743	36.969	45.782	148	188	2.47	35.6	130.1	2319.5	2314.1	1152.5	2416.2	2409.3
105	3246.7	1.792	1.544	34.678C	27.749	36.976	45.791	148	188	2.47	35.0	131.3	2322.3	2316.2	1139.5	2420.4	2413.5
104	3451.0	1.783	1.515	34.680C	27.752	36.981	45.798	161	176	2.46	36.0	129.0	2316.5	2311.6	1132.6	2416.3	2409.4
103	3758.1	1.758	1.458	34.682	27.758	36.990	45.810	152	185	2.40	35.2	124.4	2307.1	2300.5	1087.0	2410.7	2403.7
102	4065.3	1.726	1.394	34.686C	27.766	37.002	45.824	164	174	2.38	34.6	124.3	2305.7	2299.4	1085.4	2409.7	2402.8
101	4574.7	1.734	1.343	34.686	27.769	37.008	45.833	164	175	2.39	34.7	125.3	2308.9	2299.8	1075.6	2411.7	2404.7

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity

Leg 1 Station 3384 Latitude 28-15.0S Longitude 74-00.0W Date 6/10/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----------	uM/kg	----------	----------	----------	TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
122	10.7	16.451	16.449	34.344	25.141	33.714	41.916	248	-6	0.44	1.0	0.0	2081.6	2079.7	549.9	2276.4	2270.9
120	21.0	16.189	16.185	34.350C	25.206	33.788	41.999			0.51	1.6	0.0					
117	31.7	16.036	16.031	34.343C	25.236	33.823	42.039	251	-8	0.55	2.1	0.0	2040.8	2041.9	419.0	2290.4	2283.9
115	39.9	14.805	14.799	34.290C	25.469	34.102	42.359			0.82	5.9	0.0					
113	51.1	13.795	13.788	34.196	25.610	34.281	42.574	231	24	0.98	9.1	0.5					
112	60.5	12.958	12.949	34.079C	25.690	34.394	42.719			0.94	10.6	0.4					
111	76.5	12.014	12.004	34.143C	25.923	34.664	43.022	189	76	1.31	15.7	2.8	2115.6	2111.5	700.7	2267.8	2262.1
110	81.8	11.909	11.898	34.218C	26.001	34.745	43.106			1.52	17.9	4.8					
109	89.4	11.529	11.518	34.208C	26.065	34.824	43.200			1.58	18.7	5.2					
107	101.4	11.008	10.996	34.244C	26.188	34.968	43.363	139	131	1.84	21.5	7.8	2170.6	2162.3	975.0	2270.6	2265.2
106	126.7	11.380	11.364	34.531C	26.345	35.105	43.483	51	217	2.40	22.5	17.5					
105	151.2	11.223	11.204	34.620	26.443	35.209	43.592	25	244	2.55	23.6	21.4	2256.4	2242.0	1531.7	2292.8	2287.6
104	176.0	10.856	10.835	34.615C	26.506	35.287	43.684	22	249	2.56	25.4	21.7					
103	202.2	10.436	10.412	34.607C	26.574	35.373	43.786	20	254	2.57	27.5	22.4	2262.5	2249.3	1627.6	2292.1	2286.9
102	251.5	9.417	9.389	34.548	26.701	35.545	43.999	28	252	2.56	31.4	22.3	2263.1	2248.9	1658.7	2288.8	2283.7
101	303.5	8.622	8.590	34.506C	26.797	35.676	44.163	37	248	2.56	33.9	22.4	2262.4	2246.8	1621.2	2289.7	2284.6
323	353.7	8.117	8.081	34.472	26.847	35.750	44.259	53	235	2.64	33.3	22.4	2255.1	2243.2	1572.2	2290.2	2285.0
322	403.6	7.347	7.308	34.412C	26.913	35.851	44.394	93	200	2.48	32.9	19.8	2234.9	2226.1	1405.2	2287.4	2282.1
321	505.0	5.918	5.875	34.331C	27.040	36.048	44.656	173	131	2.13	29.1	17.6	2190.0	2184.4	1025.9	2288.1	2282.4
320	604.7	5.368	5.318	34.318	27.098	36.133	44.767	168	139	2.23	30.4	23.3	2200.7	2196.3	1068.1	2295.1	2289.4
319	705.6	4.929	4.872	34.366C	27.187	36.244	44.898	138	173	2.49	33.8	35.4	2230.1	2220.4	1191.1	2305.7	2299.9
318	806.8	4.445	4.383	34.410	27.276	36.357	45.034	116	198	2.63	35.5	49.5	2256.1	2249.3	1327.8	2321.5	2315.7
317	908.9	4.159	4.090	34.453C	27.342	36.437	45.127	104	213	2.73	36.2	61.0	2275.3	2268.5	1398.1	2335.1	2329.2
316	1009.1	3.863	3.788	34.490C	27.402	36.512	45.216	99	220	2.78	37.3	71.5	2289.2	2280.0	1408.9	2346.8	2340.8
315	1112.4	3.667	3.584	34.517C	27.444	36.564	45.278	99	222	2.79	37.8	80.0	2297.8	2287.7	1391.8	2357.2	2351.0
314	1212.6	3.406	3.318	34.536	27.485	36.619	45.345	102	221	2.75	37.6	86.1	2303.2	2294.5	1403.0	2363.4	2357.3
313	1417.0	3.011	2.910	34.569C	27.549	36.704	45.450	111	214	2.72	37.1	96.2	2309.5	2300.7	1336.4	2377.7	2371.4
312	1617.3	2.699	2.585	34.594C	27.598	36.769	45.532	117	212	2.66	35.9	104.2	2313.3	2303.9	1301.7	2385.3	2378.9
311	1819.4	2.436	2.308	34.615	27.639	36.825	45.601	124	207	2.58	35.3	111.5	2316.2	2307.1	1250.9	2395.0	2388.5
310	2024.1	2.241	2.099	34.632C	27.669	36.867	45.653	134	198	2.53	34.4	114.8	2314.8	2305.4	1222.2	2396.9	2390.3
309	2227.6	2.078	1.921	34.646	27.694	36.901	45.697	141	193	2.45	34.6	116.9	2311.8	2305.1	1185.1	2401.4	2394.8
308	2429.4	1.966	1.792	34.656C	27.712	36.926	45.729	148	187	2.42	33.8	118.3	2310.1	2300.7	1138.3	2403.1	2396.4
307	2634.0	1.878	1.688	34.665C	27.728	36.947	45.755	153	182	2.36	33.0	119.0	2306.4	2300.5	1121.7	2405.2	2398.5
306	2838.1	1.820	1.612	34.673C	27.739	36.963	45.775	156	180	2.35	33.4	120.5	2308.3	2302.5	1118.8	2407.9	2401.1
305	3043.2	1.778	1.551	34.678	27.748	36.975	45.790	160	176	2.37	32.6	118.1	2306.8	2301.3	1109.9	2407.9	2401.1
304	3248.0	1.730	1.484	34.682	27.757	36.987	45.805	161	177	2.34	32.5	120.7	2307.1	2302.0	1112.3	2408.3	2401.5
303	3450.4	1.692	1.426	34.686	27.763	36.997	45.818	166	172	2.33	33.0	120.6	2305.8	2301.2	1100.4	2409.2	2402.4
302	3757.3	1.664	1.367	34.688C	27.770	37.007	45.831	166	173	2.32	32.7	121.2	2306.6	2301.2	1084.4	2411.6	2404.8
301	4036.1	1.674	1.346	34.689	27.772	37.011	45.836	165	174	2.31	32.6	121.7	2307.0	2299.2	1075.1	2410.8	2404.0

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3418 Latitude 28-15.0S Longitude 80-00.0W Date 6/25/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------	----------	uM/kg	----------	----------	----------	TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
122	9.7	19.035	19.033	34.798C	24.859	33.342	41.459	233	-4	0.40	0.0	0.0	2036.0	2037.7	365.8	2320.1	2313.2
120	29.8	19.036	19.030	34.802	24.863	33.346	41.463	233	-3	0.41	0.0	0.2	2036.1	2037.6	366.7	2319.4	2312.5
117	50.6	19.047	19.038	34.805C	24.864	33.346	41.462	232	-3	0.39	0.0	0.0					
115	74.9	19.098	19.085	34.846C	24.883	33.363	41.478	231	-2	0.40	0.0	0.1	2036.5	2039.2	367.3	2321.2	2314.3
114	83.5	18.871	18.856	34.805C	24.910	33.398	41.520			0.33	0.1	0.1					
112	99.8	17.199	17.182	34.578	25.148	33.693	41.869	248	-10	0.34	0.0	0.0	2026.4	2030.9	382.6	2299.4	2292.8
111	110.1	16.208	16.191	34.481C	25.305	33.886	42.094			0.33	0.1	0.0					
110	120.0	16.223	16.204	34.530C	25.341	33.920	42.128			0.45	0.6	0.0					
108	125.9	15.938	15.919	34.514	25.393	33.983	42.200			0.53	1.6	0.1					
107	140.2	14.749	14.728	34.320C	25.507	34.142	42.401	234	17	0.62	4.4	0.1					
106	150.9	14.065	14.043	34.257	25.605	34.265	42.549	218	36	0.87	8.2	0.6	2068.7	2072.8	529.9	2276.4	2270.4
105	174.6	12.814	12.790	34.230C	25.839	34.547	42.876	201	59	1.27	13.1	2.3					
104	200.3	11.631	11.605	34.252	26.083	34.838	43.210	173	94	1.51	16.7	4.4	2130.0	2130.8	779.5	2271.7	2266.1
103	250.7	10.764	10.734	34.452	26.396	35.184	43.587	84	188	2.30	23.0	13.3	2211.3	2203.2	1240.2	2280.4	2275.1
102	301.7	10.008	9.973	34.544	26.601	35.419	43.850	39	237	2.61	27.7	18.4	2251.8	2237.3	1549.9	2286.0	2280.8
101	353.3	9.016	8.977	34.520	26.746	35.607	44.079	41	241	2.65	31.9	20.4					
323	404.1	8.037	7.995	34.457C	26.848	35.754	44.268										
322	503.7	6.532	6.486	34.355	26.980	35.958	44.539	151	148	2.29	31.2	15.6	2202.2	2193.7	1118.4	2285.3	2279.7
321	605.1	5.601	5.550	34.303	27.058	36.082	44.705	194	112	2.12	29.2	15.4	2179.8	2174.6	964.3	2286.9	2281.1
320	705.4	5.095	5.038	34.322	27.134	36.183	44.830	168	141	2.32	31.7	24.2	2205.2	2199.3	1072.8	2298.0	2292.1
319	806.7	4.607	4.544	34.364	27.222	36.295	44.965	143	170	2.54	35.0	36.4	2232.0	2223.9	1197.3	2308.9	2303.0
318	908.2	4.366	4.296	34.433	27.304	36.388	45.069	111	204	2.76	37.2	51.8	2266.2	2256.2	1340.6	2327.9	2321.9
317	1010.1	4.044	3.967	34.475	27.372	36.473	45.169	103	214	2.82	36.0	63.3	2280.8	2271.7	1385.0	2340.3	2334.2
316	1111.2	3.730	3.647	34.506	27.429	36.546	45.256	105	215	2.82	38.5	72.6	2291.5	2283.2	1376.2	2353.9	2347.7
315	1211.0	3.512	3.423	34.525	27.466	36.595	45.316	106	215	2.81	37.6	79.5	2296.1	2288.1	1380.9	2358.8	2352.6
314	1414.6	3.077	2.975	34.560	27.536	36.687	45.431	115	210	2.77	36.5	90.4	2304.8	2296.8	1330.4	2374.1	2367.8
313	1617.0	2.718	2.604	34.589	27.593	36.763	45.525	126	202	2.66	36.3	98.0	2303.8	2295.1	1255.7	2381.2	2374.7
312	1819.3	2.416	2.289	34.613	27.638	36.826	45.603	134	196	2.62	35.4	104.2	2306.3	2301.6	1231.1	2391.5	2384.9
311	2024.0	2.226	2.084	34.630	27.669	36.867	45.655	139	193	2.57	34.8	109.4	2307.6	2301.9	1199.0	2396.1	2389.4
310	2226.5	2.068	1.911	34.646	27.695	36.902	45.699	147	186	2.51	34.9	111.4	2306.1	2297.8	1157.4	2397.2	2390.5
309	2429.3	1.936	1.763	34.655	27.714	36.930	45.734	158	177	2.44	33.5	112.1	2300.3	2297.0	1130.9	2400.0	2393.3
308	2633.4	1.869	1.679	34.665	27.728	36.949	45.757	157	179	2.41	33.7	113.2	2300.6	2292.3	1099.9	2399.4	2392.6
307	2837.5	1.820	1.612	34.671	27.738	36.962	45.773	164	172	2.41	33.3	113.9	2297.7	2293.0	1092.6	2401.3	2394.5
306	3042.2	1.775	1.548	34.677	27.747	36.975	45.789	165	171	2.40	33.1	114.9	2301.8	2294.9	1096.2	2402.9	2396.1
305	3247.3	1.733	1.486	34.681	27.755	36.986	45.804	166	171	2.38	33.2	115.7	2299.0	2295.7	1084.2	2405.6	2398.7
304	3452.6	1.706	1.439	34.684	27.761	36.994	45.815	166	172	2.39	33.2	117.0	2301.8	2295.0	1072.5	2406.7	2399.8
303	3758.2	1.680	1.382	34.685	27.766	37.003	45.826	169	169	2.39	32.9	118.1	2303.2	2297.8	1075.6	2409.3	2402.4
302	4064.5	1.706	1.374	34.689	27.770	37.007	45.830	168	170	2.39	33.2	118.3	2304.0	2297.6	1068.5	2410.2	2403.3
301	4191.8	1.717	1.370	34.686	27.767	37.004	45.828	169	169	2.39	32.8	118.3	2304.2	2299.2	1078.5	2410.4	2403.5

Project/Expedition is R/V Sonne Cruise 102 C means CTD Salinity
Leg 1 Station 3420 Latitude 28-15.0S Longitude 77-00.0W Date 6/26/95 Bottom Depth n/a

Final TCO2 is the value measured immediately after Final pCO2.

Bot	Press	Temp	Pot Temp	Salinity	-------Sigma--------			Oxy	AOU	PO4	NO3	SiO3	TCO2	-----Final----		Calc. TALK	
No.	dbar	deg C	deg C	o/oo	Theta	2000	4000	----------uM/kg----------						TCO2 uM/kg	pCO2@20C uatm	Peng ----ueq/kg---	DOE
109	10.5	17.459	17.457	34.469C	24.998	33.536	41.704	240	-3	0.61	6.3	0.0					
108	30.2	17.464	17.459	34.468C	24.998	33.535	41.703	239	-2	0.62	6.1	0.0					
107	39.4	17.438	17.431	34.467C	25.003	33.542	41.711	239	-2	0.62	5.8	0.0					
106	50.2	17.416	17.407	34.464C	25.006	33.546	41.716	239	-2	0.63	5.5	0.0					
105	75.1	17.276	17.264	34.441C	25.023	33.567	41.742	238	0	0.67	6.0	0.0					
104	100.7	13.719	13.704	34.098	25.552	34.227	42.525	232	24	1.01	13.7	0.1	2055.0	2057.0	502.0	2268.6	2262.3
103	125.6	12.885	12.868	34.109C	25.730	34.437	42.764	216	45	1.28	17.7	0.8					
102	150.8	11.829	11.810	34.158C	25.972	34.720	43.085	188	78	1.67	23.3	3.1	2120.1	2122.2	738.7	2271.3	2265.4
101	176.1	11.121	11.099	34.244C	26.169	34.945	43.336	152	118	2.03	27.3	6.4					
123	202.1	11.234	11.209	34.244	26.150	34.921	43.308	153	117	2.02	26.7	6.6	2156.5	2155.4	919.8	2272.7	2266.9
122	252.4	11.642	11.609	34.743C	26.464	35.212	43.577			3.04	28.5	25.0	2268.9	2259.1	1617.4	2304.8	2299.1
121	302.1	10.517	10.481	34.623C	26.575	35.370	43.781	6	267	3.03	28.2	24.9	2272.3	2259.2	1621.7	2304.1	2298.5
120	403.3	8.729	8.685	34.542	26.809	35.683	44.167	29	255	3.02	43.4	23.4	2269.8	2256.5	1686.4	2295.5	2290.0
119	504.7	7.130	7.082	34.425	26.955	35.904	44.457	94	201	2.78	43.9	20.6	2235.9	2226.3	1363.4	2292.6	2286.9
118	605.3	5.994	5.941	34.338	27.037	36.041	44.646	162	141	2.46	39.3	17.1	2197.3	2193.4	1077.4	2291.0	2285.1
117	806.6	4.955	4.889	34.394	27.208	36.263	44.916	116	195	2.92	44.8	38.8					
116	1009.3	4.160	4.082	34.461	27.349	36.444	45.134	101	216	3.07	47.3	60.7	2279.0	2271.5	1396.5	2339.2	2333.0
115	1516.0	2.994	2.885	34.565	27.548	36.704	45.452	115	211	2.98	46.3	93.5	2304.9	2295.8	1305.8	2376.4	2369.8
114	2023.3	2.285	2.142	34.622	27.658	36.853	45.638	135	197	2.83	42.7	109.5	2311.0	2303.8	1203.9	2398.0	2391.1
113	2531.2	1.930	1.748	34.656	27.716	36.932	45.737	155	180	2.70	40.7	114.8	2305.6	2298.3	1129.9	2402.2	2395.2
112	3041.1	1.776	1.550	34.676	27.746	36.974	45.788	162	175	2.67	41.4	117.1	2305.9	2299.7	1104.8	2407.5	2400.4
111	3552.0	1.666	1.390	34.688C	27.768	37.004	45.827	167	171	2.61	39.8	118.3	2302.9	2296.6	1068.9	2409.5	2402.3
110	3976.2	1.678	1.357	34.686	27.769	37.007	45.831	167	171	2.61	39.3	118.9	2305.1	2298.4	1070.0	2411.3	2404.1

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